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# THE VIRGINIA JOURNAL OF SCIENCE

Volume 13 (New Series), 1962

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# THE VIRGINIA JOURNAL OF SCIENCE

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JANUARY, 1962

VOL. 1

## THE ALLEGHANY COUNTY, VIRGINIA DEER HERD

Robert H. Giles, Jr.<sup>1</sup> and Jack V. Gwynn<sup>2</sup>

*Virginia Commission of Game and Inland Fisheries*

The whitetail deer, *Odocoileus virginianus* spp., is Virginia's leading big game animal. Annually, deer provide hundreds of thousands of hours of recreation to hunters, make important contributions to the economy of many localities and industries, and offer immeasurable value to hundreds of nature lovers. Trophies, hides, and food are also their important contributions. On the other hand, deer are capable of doing great damage to forest reproduction, agricultural crops, and also present extreme highway hazards. Because of great economic as well as sentimental value, deer must be managed to insure survival, control damage, maintain populations, and allow a harvestable surplus that will provide the greatest good to the most people over the longest time. Such management requires comprehensive knowledge of the herd's population dynamics. This paper reports on the information now available on the county herd and its relation to its environment and to the people of that environment.

The Alleghany County deer herd is not unique among Virginia herds. The county boundary is not isolatory and many of the characteristics of the herd will be in common with deer of surrounding counties.

### HISTORY

During the sixteenth century, deer were numerous in Virginia, particularly in the costal area. The heavily forested areas of the Appalachians undoubtedly had fewer deer per square mile than many areas today because the clear understory of the mature forests did not provide needed food. Nevertheless, deer were abundant and played a vital role in the lives of the Indians as well as settlers. Early writers frequently recorded the presence of deer and described deer hunts (Taylor, 1956).

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Virginia first adopted laws concerning deer in 1699; in 1792 the state prohibited fire hunting; and in 1801 protected deer from January 1 to August 1.

Fires, poaching, dogs, agricultural development, and urbanization all contributed to the virtual disappearance of deer in Alleghany County. County wardens in 1923 reported an estimated 15 deer killed; the reported kill of Virginia was only 793. Following that year, deer vanished from the county. The occasional sight of a track was newsworthy and gathered crowds. Hunting deer with dogs west of the Blue Ridge Mountains was prohibited on August 18, 1932.

A U. S. Forest Service map dated 1936 indicated a deer herd in Alleghany County in the Smith Creek area. The herd ranged in the north-central portion of the county extending from Falling Spring Creek to approximately two miles east of Wilson Creek.

The U. S. Forest Service, Commission of Game and Inland Fisheries, and local citizens began stocking deer in the county about 1932. Records of releases are meager and scattered. Stocking was done in the watersheds of Johns Run in 1938 and Pounding Mill Creek in 1948. Cost per deer delivered in loads from 15 to 20 from Michigan was \$45 each. Stocking proved successful. Deer hunting was closed on August 18, 1932, in sixty-three counties. Alleghany was one of the three counties west of the Blue Ridge retaining an open season though other western counties adopted a November 15 through 30 season.

### CHARACTERISTICS OF ALLEGHANY COUNTY, VIRGINIA

Alleghany County is located in west-central Virginia and borders West Virginia. It is within the Appalachian chain, and is primarily underlain with Bralier shale and various sandstones and shales of the Devonian and Silurian periods. Only few localized limestone formations occur. Elevations range from 950 feet to 4049 feet. Mean winter temperatures are 34°F.; summer temperatures, 70°F. The average annual precipitation is 38 inches. The 1960 census revealed a human population of 23,190.

Forty-six percent (208 square miles) of the total 451 square miles of the county is managed by the U. S. Forest Service. A total of 566 farms comprised 28.3 percent of the county area in 1950 with 47 square miles in cropland, pasture, and other use. Farm woodlands totaled 80 square miles. In 1957 the country contained 391 square miles of suitable deer range.

The major forest cover is second growth hardwood with less than 10% in pines. Forests under private ownership are largely operated on a short-cutting rotation providing excellent deer food and cover. At present there

is not enough agricultural land nor a large enough herd to cause severe crop-damage complaints. Alfalfa and corn are readily eaten by deer and suffer the greatest damage. Pulpwood is in great demand by the West Virginia Pulp and Paper Company mill in Covington. Pulpwood cutting practices contribute to a growing herd by providing oak sprouts (*Quercus* spp., laurel (*Kalmia latifolia*), deerberry (*Vaccinium* spp.), huckleberry (*Gaylussacia* spp.) greenbriar (*Smilax* spp.), many forms of the compositae, sassafras (*Sassafras albidum*), sumac (*Rhus* spp.), and on better sites, tulip poplar (*Liriodendron tulipifera*), and white pine (*Pinus strobus*). Cut-over dry shale ridges revert to Virginia (*Pinus virginiana*), table mountain (*P. pungens*), or pitch pine (*P. rigida*) with early ground cover of greenbriar (*Smilax* spp.), blue berries (*Vaccinium* spp.), sumac (*Rhus* spp.) sassafras (*Sassafras albidum*) and scrub oak (*Quercus ilicifolia*) if seed is available.

### CHARACTERISTICS OF THE DEER

Multiple sources of stocking have resulted in the Alleghany County deer being an indistinguishable mixture of *Odocoileus virginianus virginianus*, *O.v. borealis*, and perhaps *O.v. macrourus*. Deer came from Michigan, Wisconsin, Pennsylvania, North Carolina, Alabama, and coastal Virginia. There is need for physical measurements of the kill for several years to compare with subspecific measurement data presented by Remington Kellog (Taylor, 1956).

Antler development reflects the nutrients available to a deer. Annual replacement of antlers reflects changes in available food and nutrients. Range shortages of food, known as heavy or overbrowsing, are most prominently shown in antler development. Only one report of antlers on a female deer in 1958 has been received by the senior author.

Figures on antler development without age data can only show trends. Age and antler data are needed for the county to appraise the effects of forage on herd condition. Generally, many points on one and one-half to two and one-half year old deer would indicate adequate food; few points or narrow beam diameters on a sample of older deer would indicate poor range. The later condition would usually indicate the need for immediate management steps.

Table 1 shows that the percentage of deer with nine or more points decreased slowly with the exception of the 1958 data. This trend suggests a gradual range deterioration with need for increased harvest or improved, increased management practices.

General biological information on Virginia deer will be beneficial in interpreting data on population dynamics and will assist in developing a management plan for the county.



Table 1. Antler development in Alleghany County deer as indicated by total number of legal points on both antlers of male deer.

Year	Number of points			Totaled antlered deer
	1-3	4-8	9 and over	
1955	56	120	44	220
Percent	25.5	54.5	20.0	100
1956	99	104	30	233
Percent	42.5	44.6	12.9	100
1957	111	127	34	272
Percent	40.8	46.7	12.5	100
1958	126	154	36	316
Percent	39.9	48.7	13.9	100
1959	183	188	42	413
Percent	44.3	45.5	10.2	100
1960	132	185	40	357
Percent	37.0	51.8	11.2	100

The "rut" or breeding season occurs in the fall with a peak occurring between November 15 and 20. Deer have an oestrus of 24 hours; if fertilization does not occur, oestrus occurs about 28 days later (Jenkins and Bartlett, 1959). A male deer can service as many as 17 does in one season (Taylor, 1956). Gestation requires approximately 196 days varying from 189 to 222 days. Young are born in May and June with the peak about the second week in June. The number of young produced is largely dependent on deer nutrition. On over-stocked range where deer are competing for sufficient nutritious foods, fawn production may be less than one per doe. On good range, production is 2.0 per doe. Twins and triplets are the rule on excellent range. Fawns weigh an average of seven and one-half pounds. Taylor (1956) reports that males comprise 51 to 52 percent of the fawns.

Antler development varies with food availability and nutrition; yearling males can develop antlers with six and eight points or more. Antlers are shed every year from late December to March. They are seldom seen because of being rapidly eaten by squirrels (Sciuridae), mice (Cricetidae), wild dogs and other woodland creatures. Antlers grow during spring and summer covered with skin and short hair called "velvet". This covering is shed in late summer and early fall. Antlers are "polished" on small saplings, usually one that is aromatic such as red cedar, cherry, or sassafras. Deer may breed when six to eight months old; bucks attain sexual maturity in 18 months. Longevity of the whitetail is 15 years, though in the wild,

deer over eight years of age are rare. There is no evidence of migration within the county herd. Four pied-bald deer from the county have been reported.

### FOOD REQUIREMENTS

Pennsylvania studies (French, *et al.* 1955) reveal that the daily food requirements of a 100 pound deer are 6300 calories or six to eight pounds of good deer browse. A 150 pound deer requires at least ten to 12 pounds of browse of which 13 to 16 percent must be protein for best growth. Six hundred fourteen species of plants have been listed as being eaten by the whitetail. Preferred foods in Alleghany county include grape (*Vitis* spp.), dogwood (*Cornus florida*), red maple (*Acer rubrum*), greenbriar (*Smilax* spp.), and tulip poplar (*Liriodendron tulipifera*). Some plants are palatable only at certain times of the year. The seeming abundance of year-around browse is misleading. Pulpwood cutting, within limits, is beneficial to the deer herd. Presently the pulp mill in Covington uses approximately 1200 cords of pulpwood a day. Annually, 49,000 cords of hardwood and 9700 cords of pine are supplied by Alleghany County. If this volume were obtained from clear-cut operations, it would mean that each year approximately five square miles of the county are treated beneficially for deer. Since much of the volume is obtained from selective-cutting practice, five square miles is the maximum area "treated." Under the most ideal conditions, ten acres are required to support one deer (French *et al.*, 1955a). The deer herd can only increase to the limits of its food supply, after which weight, productivity, and antler development are greatly reduced.

S. P. Davey (1956) made a survey of seven pine plantations in the Dolly Ann - Smith Creek watersheds of the county. In a letter June 29, 1956 to the U. S. Forest Service District Ranger he reported deer browsing on 9% of the white pine in three Smith Creek plantations; 52% in a Dolly Ann plantation, and 78% on another Smith Creek plantation. Average browsing of seedlings amounted to 63%. He concluded that browsing takes place in late winter and that "the deer had seriously effected the pine plantings in this section of the James River District." He also concluded these were minimum damage figures since some completely dead seedlings were overlooked.

Alleghany County deer do not "yard" or assemble for winter feeding as do deer in northern states.

### OTHER REQUIREMENTS

The whitetail deer is very hardy and can survive under a wide variety of conditions. Food, cover, and protection against dogs and illegal hunting are their major needs. With big game, cover requirements do not appear

to be as important as with small game species. Laurel (*Kalmia latifolia*), rhododendron (*Rhododendron* spp.) scrub oak (*Quercus ilicifolia*), and the sprout growth and brush of the second-growth mixed hardwood-pine forest provides ample protection from wind, rain, snow and serve as refuge from hunters.

Water is generally available throughout the county. Deer, except pregnant does, those exercising heavily, or those eating much dry food apparently need little free water. Some is being provided by small water-holes bulldozed by the Commission of Game and Inland Fisheries in areas of intermittent streams and on mountain and ridge slopes.

Information on the needs for salt is inconclusive. We are inclined to agree with others that it is a mild attractant rather than a necessity. A natural lick is said to have been present in the 1930's in Fudge Hollow. Greatest use of salt has been observed on Potts Mountain near the Craig County line.

Climate in Alleghany County appears to have little effect on the deer. Winters are not severe; summers are not excessively hot. Potentially harmful insects and parasites found in the more southern states are not present in great numbers (Gwynn, 1960a). Extremely low temperatures, fog or heavy rain during the hunting season reduce hunting pressure and materially effect herd management.

## POPULATIONS

Figure 1 shows the trend in deer kill. Aside from greatly increasing deer populations, the eruptive nature of the graph may be accounted for by increased numbers of hunters, more lenient seasons and abandonment of the forked-antler law for legal buck deer. Hunting pressure dropped slightly in 1958, though the kill continued to increase. Doe hunting was first allowed in 1956.

The annual deer kill is considered by some biologists to be a representative sample of the existing herd. Sportsmen are required by law (since 1947) to check their deer at one of 12 official checking stations within Alleghany County. Data on deer kill are gathered from cards filled out on each checked deer and successful hunter. Computations based on the above premise do not hold under critical scrutiny. The greatest difficulties encountered in data analysis are a highly mobile population, one of unknown size, and one of unknown susceptibility to hunting. The kill figures, however, do provide a workable index and one whose accuracy is within the limits of today's management needs and objectives.



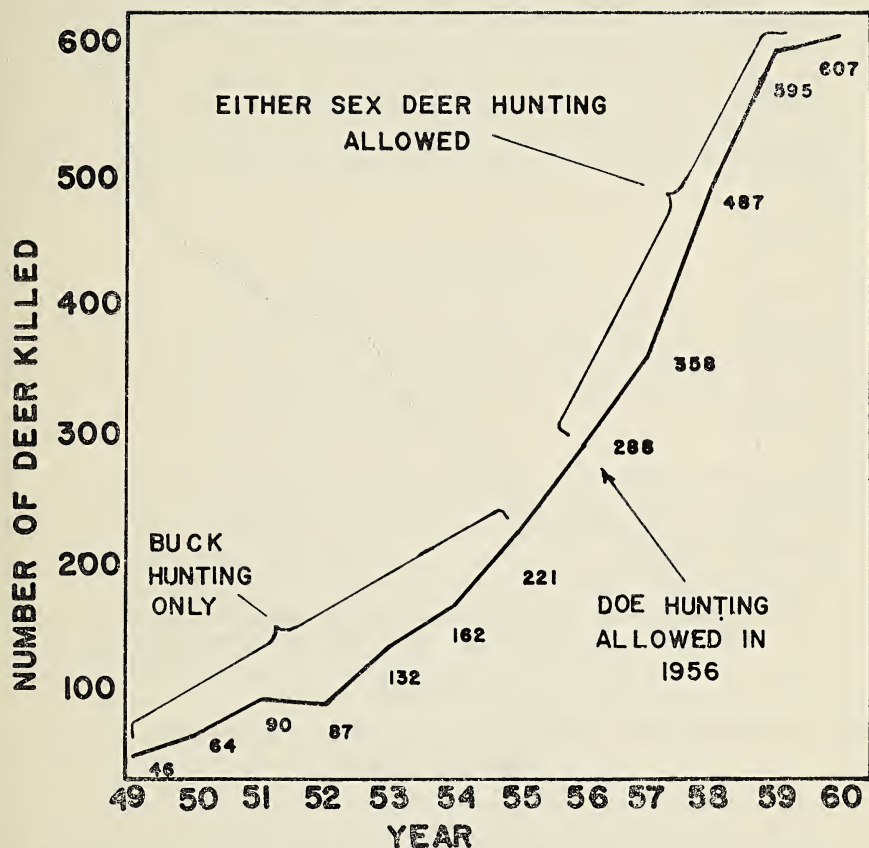


Figure 1.—Reported Alleghany County total deer harvest, 1949-60.

Data on antlered male deer legally taken since 1949 are available. The opening of the season to antlerless deer hunting has caused difficulties in comparison of annual kill figures. Trends in herd populations can be best studied on the basis of antlered deer per square mile of forest range. Figure 2 is based on forest acreage of 391 square miles. Forest survey area figures were revised from 394 square miles to 391 in 1957. The total forest area has increased 13 percent in Virginia's mountain counties from 1940 to 1957. The tendency to a periodic four year decline in deer kill should be further investigated. It may be due to most crop extremes, seasonal changes, coincidences, or a combination of these and other factors.

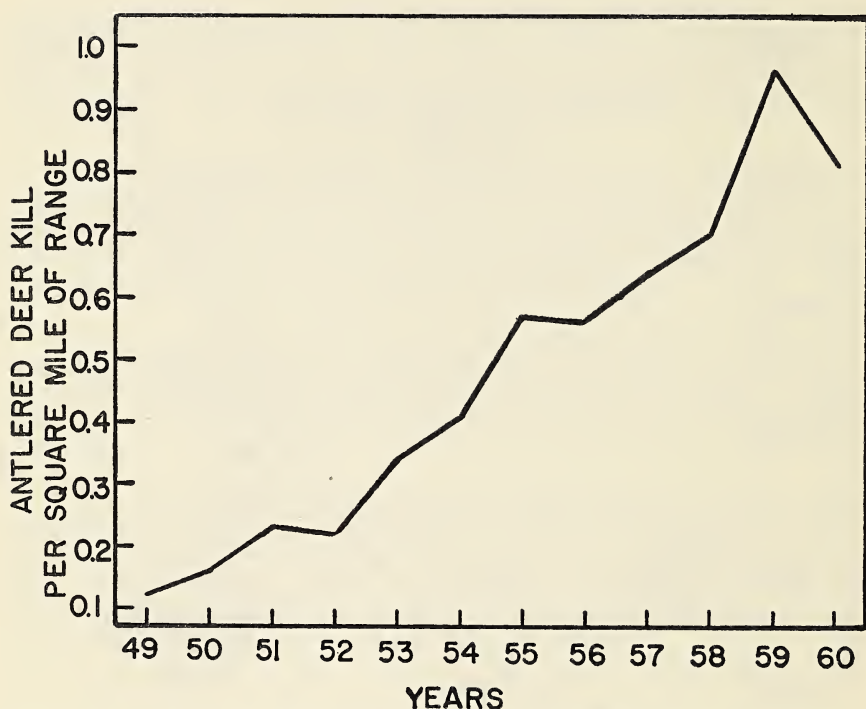


Figure 2.—Antlered deer killed per square mile of forest range in Alleghany County, 1949-60.

In order to obtain comparable data on deer kill, it is desirable to attempt to eliminate differences in types of seasons. This can be done on the basis of antlered buck kill. Davey (1957) found that approximately 30 percent of the female kill was composed of fawns. "The assumption is made that an equal number of male fawns and female fawns are taken and thus . . . (24 to 30 percent of the female kill) is subtracted from the total male kill . . ." This results in the antlered kill figure. Computations by Gwynn in 1958 (Unpub. Pittman-Robertson Quarterly) derived a factor of 11.8 which, if multiplied by the antlered harvest, gives an estimate of the total population. The antlered buck harvest in 1959 was 373. The total population estimate is 4400 deer. Davey (1957) also estimated that the antlered harvest is 10 percent of the total herd, thus a herd size estimate of 3730 deer results. Using the figure of 4400 deer, there are 9.7 deer per square mile in Alleghany County; one deer per 66 acres. Considering only forested deer range, there are 11.3 deer per square mile; one deer per 57 acres.

By considering stable regulations and projecting deer populations in Alleghany County by deer kill figures it appears that 650 deer may be killed in 1961. If the antlered harvest is between 60 and 70 percent of the total kill as in 1959 and 1960 there will be a herd of one deer per 50 acres in 1961. Considering that range damage has become evident when browsed by populations of one deer per 30 to 40 acres, it appears that the Alleghany County deer herd is approaching the carrying capacity of its range.

### THE ILLEGAL KILL

At present there is no way of accurately appraising the influence of illegal kill on the herd. Wisconsin hunters killed and left in the woods 181 deer for every 100 bucks legally taken (Dahlberg and Guettinger, 1956). A Florida estimate (Strode, 1954) was that one illegal deer was taken for every legal deer bagged.

In a telephone survey of six percent of the successful hunters in Alleghany County in 1958, forty-one percent had seen illegally shot deer left in the woods. Hunters' most frequent answer to the question: "What would be your guess as to how many deer are not checked?" Was "Oh, a lot!" Twenty-four percent gave no opinion, though others ranged from 500 deer throughout the state to 50 percent of the total statewide kill. The average estimate of five hunters expressing opinions based on what they had observed afield and had heard was an illegal kill of 160 deer, or 30 percent of the total annual kill. Regardless of the many fallacies evident in obtaining this figure, it is our opinion that it is very realistic and can be used with considerable reliability.

Four hunters (13.8 percent of those sampled) indicated that their deer had been killed in another county and had been brought into Alleghany and checked. Though this practice is not illegal, it evidences false statements to checking station operators or shortcomings on the part of the operators. It may be hypothesized that inter-county exchanges will balance themselves. This should be checked and if found invalid, changes should be made in game reporting regulations or checking station procedure.

There are six wardens and special wardens in Alleghany County that offer year-around checks on illegal kill.

Of the hunters contacted, 13.8 percent gave evidence of having illegally taken deer on other hunters' licenses.



### OTHER LOSSES

Accidental losses occur when deer run into wire fences, becoming entangled when jumping fences, and being hit by automobiles and trains.

Bobcats have made several observed kills of deer. A hunter in adjoining Bath County, in 1959 observed a bear following a deer which had an injured leg. These observations are considered examples of sanitary predation.

Dogs, though causing local damage, are controlled and do not present a serious problem. Constant control must be exercised to keep this threat to a stable herd in check.

### THE HUNT AND THE HUNTER

Becoming more evident in conversations with deer hunters is the expressions of decreased recreational value of deer. Axiomatic is: "the more you have of something; the less highly you regard it." This may be true of a large whitetailed deer herd; its capability of providing recreational value is, to a point, inversely proportional to its size. As the chances for a county resident hunter killing a deer increase, the desire to kill one decreases. However, if the resident hunter is losing interest at the present time his pressure on the deer herd is more than being replaced by new hunters from the cities and by shifts of hunters from poor hunting areas.

Gwynn (1960), measuring hunter pressure by big game damage stamp sales in the adjoining counties of Bath, Botetourt, Craig and Rockbridge, found a nine percent increase in hunters in 1958, a 12 percent increase in 1959 and a 13 percent increase in 1960. This is an increase in damage stamp sales of 38 percent in the past three seasons. In those counties which issue damage stamps, it is unlawful for any person to hunt bear or deer without obtaining this special one-dollar stamp.

Over twice as many hunters in Alleghany County use a rifle as a shotgun. Many hunters use bow and arrow but take less than five deer per year. Hunting during the one week season is done by man-drives toward stands, by still hunting, and by waiting silently by deer trails.

A telephone survey of 20 percent of the 1958 successful resident deer hunters in Alleghany County having telephones (six percent of the total number of successful deer hunters in the county) yielded information useful in law enforcement, management, and research. The survey was based on a 20 percent systematic random sample of successful Alleghany County hunters having telephones. Eighty-one percent of the hunters hunted on National Forest lands and killed 56 percent of their deer there. Forty-

two percent of the successful hunters scouted around before the season to select hunting sites and to find deer sign. The average shot distance was 63 yards. Hunters carried their deer about 0.6 mile to a car or jeep. The average distance walked on the day on which they shot the deer was 4.1 miles. Each successful hunter hunted an average of 30 hours during the week of deer season. This is not a true picture of the time required to kill a deer, for many hunters engaged in drives only, after they had killed their deer. Generally, hunters hunt an average of nine hours a day during the week of deer season until they get a deer. Man-hours of hunting required can be approximated from Table 2 in combination with data on total number of hunters afield. Hunters reported all healthy deer and observed no abnormalities. All of the deer were completely eaten or had been frozen for later use. Only 54 percent of the hides were used; the rest was thrown away. Hunters drove an average of 20 miles on the day they killed a deer. Similar mileage can be expected prior to the date of kill during the season. Hunters had shot an average of 5.5 deer in their lifetimes, and had hunted an average of 17.7 years. Thus, an average of one deer every 3.2 years is obtained. It is expected that this kill figure will increase as the herd increases.

Contrary to what might be expected, in 1958 non-residents of the county as a group took a greater percentage of large antlered deer than did residents. They also took a larger percent of deer in the one to three antler point category (see Table 3). A study of the antlered deer killed each day of the season by non-residents of the county revealed no significant variation in trophy buck kill throughout the season.

Table 2 shows the distribution of deer kill during the legal season. Since the objective of management is to insure an optimum amount of recreation for the most people over the longest time, it appears that this has been largely accomplished with the 1959 season. This season obtained higher kills throughout the week, insured more hunters of success during the last three "hunters' choice" days, and provided ample hunting for the "buck only" hunter. The season also brought the harvest closer to the desirable equal antlered and antlerless proportions. The 1960 season which was first three days "hunters' choice", the last three days "bucks only," allowed a higher kill, equal recreation, brought the male to female kill ratio closer to 1:1, and eliminated much of the illegal-kill waste of many doe deer. This season most nearly approaches the objectives of an extended either-sex season.

### PROBLEMS

There is much need for information on hunting pressure and its trends. Without this, kill figures cannot be properly evaluated since total kill

Table 2.—Daily deer kill in Alleghany County, Virginia, 1955-1960

Season Type	DAYS OF SEASON								
	Kill Antlered	Kill Antlerless	1st	2nd	3rd	4th	5th	6th	Unknown
1955— 6 day .....	221	0	76	44	25	27	17	32	0
bucks only									
Percent .....	100	0	34	20	11	12	8	15	0
1956— 5 day									
bucks only, 1									
day hunters choice	220	68	74	28	28	37	17	104	0
Percent .....	76	24	25	10	10	13	6	36	0
1957— 4 day									
bucks only, 2									
day hunters choice	251	109	71	49	43	19	113	62	1
Percent .....	70	30	20	14	12	5	32	17	0
1958— 4 day									
bucks only, 2									
day hunters choice	315	172	69	38	43	36	152	148	1
Percent .....	65	35	14	8	9	8	31	30	0
1959— 3 day									
bucks only, 3									
day hunters choice	374	221	98	67	22	130	129	149	0
Percent .....	63	37	16	11	4	22	22	25	0
1960— 3 day									
hunters choice,									
3 day bucks only	318	289	180	162	118	48	35	54	0
Percent .....	63	37	30	27	19	8	6	9	0

Table 3.—Comparison of antlered deer taken by Alleghany County residents and non-residents, 1958.

	ANTLER POINTS			Total Deer
	1-3	4-8	9 up	
Residents .....	101	134	27	262
Percent .....	39	51	10	100
Non-residents .....	24	21	9	54
Percent .....	45	39	16	100



is a function not only of the population of the herd but also of the volume and vigor of the hunt. Population trend studies and censuses must be continued with further refinement of the relationship of antlered buck kill to total population.

Additional browse studies are needed to determine the influence of deer on the range. The two exclosures presently established in the Potts Creek and Smith Creek drainages should be studied. Browse and range studies are necessary to insure a balance between forest, agricultural, and recreational interests.

Physical measurements of adult deer should be made to more accurately determine sub-specific characteristics of the herd.

More information is needed on the influence of diseases on the herd and its relationship to livestock diseases. Gwynn's (1960a) report indicates diseases are not significant in nearby counties.

An effort should be made to determine the extent of the illegal and accidental deer kill within the county.

Experiments should be conducted on management techniques particularly to determine the importance and best use of salt, water impoundments, and small forest openings. Studies are critically needed to determine how to achieve compatibility between deer management and timber management objectives.

## DEER MANAGEMENT

Land is a significant factor in deer management. Conflicts arise in land use that necessitate deer management be an equitable balance between farmers, foresters, industrialists, sporting goods dealers, suburban dwellers, hunters, nature enthusiasts, and — the deer.

Deer, as other non-migratory wildlife, are the property of the public, the State. Alleghany County is not intensively cultivated so there is little conflict between deer and farmers. More intensive farming and forestry and consequently conflict are expected in the future. There is now a problem and it will become increasingly more evident between the farmer and forester who want less deer damage, the hunter who wants more deer, and the businessman and industrialist who want greater trade from deer hunters as well as a sustained between-the-season trade with land users. These problems must all be resolved in a plan of management that will insure the objectives of conservation. Basically, the major questions of deer management are: (1) how many deer are needed for maximum human welfare? and (2) how can this number be produced or maintained? The answers to these must come through evaluations of

present populations in relation to range capacities, maintaining an optimum breeding density, and harvesting the full annual surplus. ". . . It is preferable to support half the present number of adult does, each producing twin fawns, than to carry larger numbers of adults on restricted feed for the same production of young" (French *et al.* 1955a).

The most important deer management tool is effective legislation. Laws must be passed that will allow maximum recreation, a harvest that removes the annual surplus, and maintains a breeding stock in balance with the ability of the range to support it. The health of Virginia's deer herd is presently largely controlled by county-by-county hunting laws.

Reliable guide figures are needed for sound legislative action. The Virginia Commission of Game and Inland Fisheries encourages a season allowing both sexes to be killed when the antlered kill reaches .25 per square mile of forest range. West Virginia biologists (Schultz, 1957) have established the figure of .75 or more antlered deer killed per square mile (in an area similar to Alleghany County) as the guide for opening a six-day, either-sex season. If less than .33 antlered deer are killed per square mile of forest range, the season would revert to bucks only. This season should be retained until the kill exceeds .33 per square mile for two successive seasons. The goal in Virginia is to harvest an equal number of male and female deer. In 1959 in Alleghany county, the ratio of males to females killed was 2.5:1; in 1960, 1.7:1. A bucks-only season allows only one-third of the herd to be taken. It was an effective tool when the herd was increasing but should be resorted to only under the condition just described.

Other management practices and techniques are to provide year-around water in critical areas, to clear-cut small acreages on areas of high-priority deer management, to encourage timber stand improvement practices such as slashing that will temporarily provide increased browse, to encourage better utilization of the meat and hides of deer taken, and to use salt in remote areas near where crop damage is occurring or road-kills are frequent. Forest fires encourage browse production and temporarily increased nutrition but the detrimental long-term effects of the use of fire do not justify its use as a deer management tool within the county.

Other suggested management techniques that should be carefully studied and experimentally tried are (1) compensatory payment to farmers who involuntarily feed deer, (2) wildlife damage insurance, (3) withheld damage payments to farmers not allowing hunting on lands on which damage is received, (4) zoning of the county on a watershed basis to establish priorities for deer management, (5) variable land taxes based on deer damage, use and economic influence, (6) privately owned commer-

cial shooting grounds, and (7) organized farmer-sportsman cooperatives for deer management and hunting.

Regulated out-of-season killing of crop-damaging deer should be encouraged and deer so killed given to the parties damaged and to public institutions.

Publicity to encourage increased deer harvest and to stimulate recreational use of this animal within the county should be considered.

A continuing program of education must be waged to maintain a stable herd, encourage legal harvest, discourage illegal hunting, control free-running dogs, promote research, and insure optimum recreational use of this wildlife resource.

### SUMMARY

The whitetail deer is Virginia's leading big game animal. This paper reports the information now available on the Alleghany County herd and its relation to its environment and to the people of that environment.

A brief history of the herd is presented from the sixteenth century to present including available stocking records. Characteristics of Alleghany County are discussed as they relate to the herd. A general summary of the life history of the deer is given as an aid in interpreting data on population dynamics. Food requirements and range conditions are described along with requirements for cover, water, salt, and the influence of climate.

Population data is based primarily on deer kill figures reported annually by hunters. There is an average of one deer per 57 acres of forest range in Alleghany County.

A telephone survey of successful hunters in 1958 disclosed the following: hunters carried their deer .6 mile to a car or jeep after the kill; the average shot distance was 63 yards; only 54 percent of the hides were used; hunters drove an average of 20 miles to hunt; and that they had killed an average of 5.5 deer in their lifetimes. Information is presented on the illegal kill.

Present hunting season regulations are unsatisfactory in obtaining the desired deer kill and hunter recreation.

Research needs are outlined as are suggestions for management practices.



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## DETECTION AND RADIAL LOCALIZATION OF ECCENTRIC SPOTS OF LIGHT<sup>1</sup>

E. RAE HARCUM, *The College of William and Mary*

Visual sensitivity, according to the consensus of experiments employing different visual tasks, is greatest in retinal areas horizontally displaced from the fovea, and poorest in sectors above and below the fovea. The equal-sensitivity contour, it has been proposed (Harcum & Rabe, 1958), can be generally described by the function in Fig. 1 which is labelled as the *s* factor. Greater distance from fixation implies superior sensitivity. Also shown in Fig. 1 is an error contour, labelled the *l* factor, which is produced by a hypothesized localization factor. The visual task producing this function requires *O*s to estimate the radial position of a suprathreshold eccentric target. The radial-localization accuracy is greater in horizontal and vertical directions from the fovea than it is in diagonal directions (Leibowitz, *et al.*, 1955a). Luminance and duration of the stimuli, which affect detection thresholds, do not influence localization errors (Leibowitz, *et al.*, 1955a, 1955b).

The present study attempts to differentiate experimentally between sensitivity and radial-localization functions using the same basic apparatus and procedures.

### METHOD

The target-field in a Dodge tachistoscope simulated a radar scope. It contained a central white fixation cross, white spots marking 5° radial intervals, and white numerals indicating degrees clockwise from above fixation at 10° intervals. The diameter of the scope face between markers was 15.2°, viewed at 23.5 in. Field luminance was .069 ft-L.

A circular target, 5' in diameter, could appear 5.8° eccentrically on one of the 72 radii of the visual field at 5° intervals from above fixation. The target luminance, provided by fluorescent flash tubes, was about .006 ft-L.

In each of nine 2-hr. sessions the *O* observed binocularly one target on each of the 72 radii in haphazard order with exposures of about .05

<sup>1</sup>The actual work on this project was done while the author was a member of the staff of the Vision Research Laboratories, and was supported by the Operations Research Department of the Willow Run Laboratories under a University of Michigan contract with the U. S. Army Signal Air Defense Engineering Agency, Contract No. DA-36-039-SC-64627.

The author thanks Dr. S. B. Williams and Miss Dorothy W. Dyer for critical reading and suggestions for improving this report.

sec. Another 72 such observations employed .15-sec. exposures. Also, one *verierfehlen* was given (i.e, no target presented) at some time during each group of 72 observations.

The Os, both having normal vision, were the author and his experimental assistant.

Before each experimental session with the shorter exposure, a number of preliminary observations provided a basis for adjusting the duration slightly, if necessary, to a value intended to produce detection of about 50% of the targets.

The O reported after each exposure whether or not he had seen the target, and his best guess concerning its radial location to the nearest 5° marker.

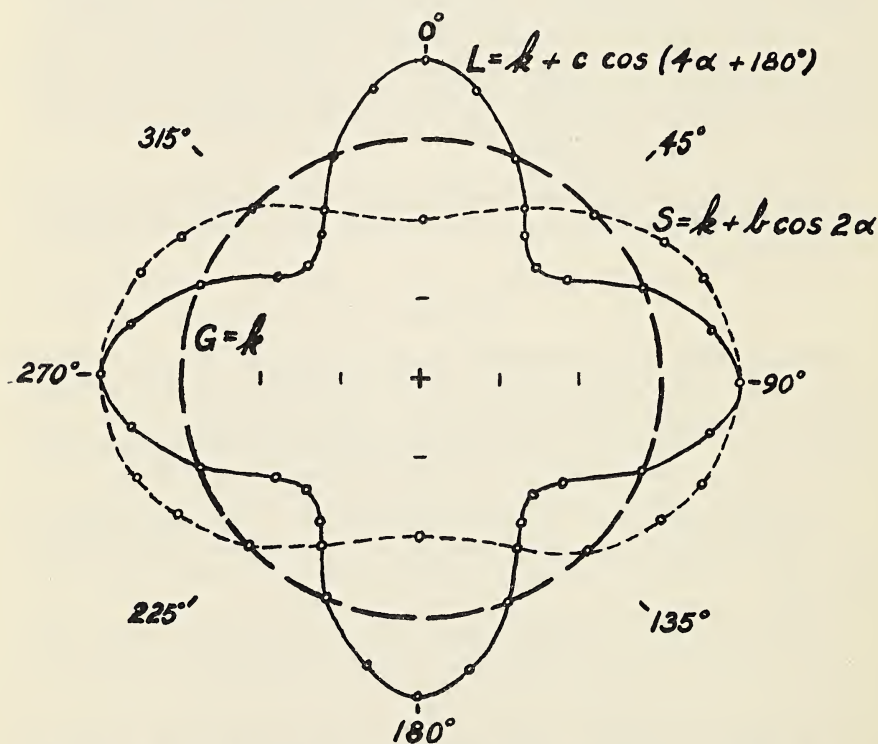


Fig. 1.—Predicted shapes of the equal-error contours produced by the  $l$  and the  $s$  factors, compared to a  $g$  factor which yields equal performance for all radii.



## RESULTS

The number of "Yes" (i.e., detection) responses per target-sector (composed of three adjacent radii) for both durations of exposure are shown in Figs. 2 and 3 for Obs. ERH and WHB, respectively. As predicted for the detection of stimuli, both *Os* exhibit elliptical contours for both durations, with the long axes oriented approximately along the horizontal meridian.

By making two reasonable assumptions, one can distinguish between spurious localization errors, which are due to failure of detection, and true localization errors. First, the guesses for a subthreshold target will

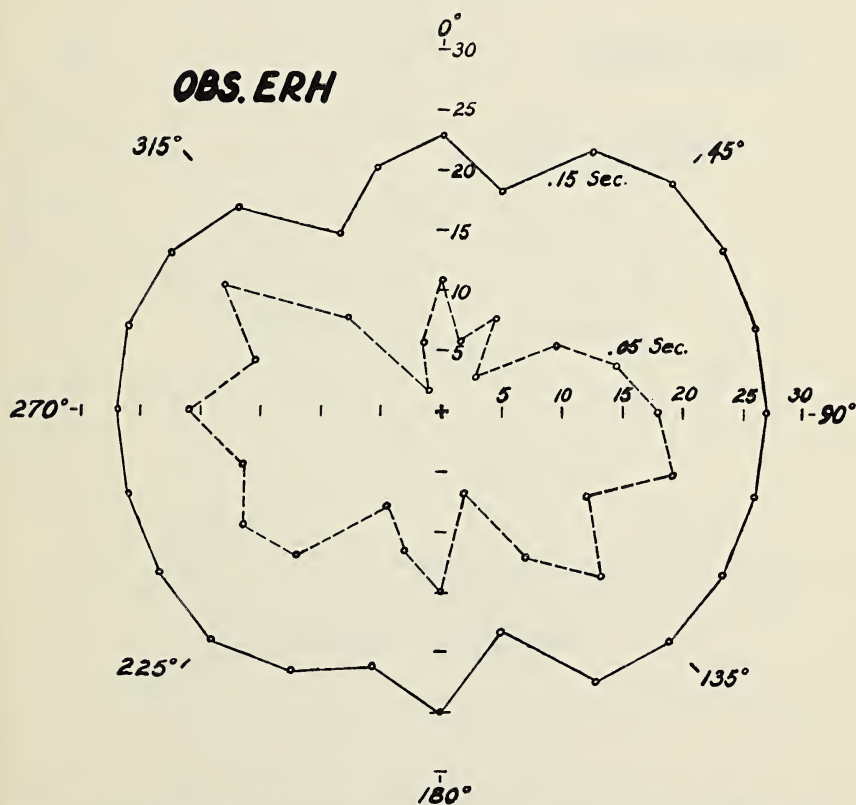


Fig. 2.—Number of "Yes" responses per 15° sectors for Obs. ERH at two exposure durations.

be determined by chance. Therefore, they should be about equally distributed from  $0^\circ$  to  $180^\circ$  in error. Second, there must be a critical distance from its true location within which a detected target will be localized. Thus, a "critical sector" is bounded on either side of the correct radius by a distance within which the target has a greater-than-chance frequency of being localized.

Calculation of critical sectors are shown in Figs. 4 and 5, in which localization errors cumulated to  $90^\circ$  are illustrated for Obs. ERH and WHB, respectively. The data-points which fall above the extrapolation of the straight chance-error line indicate target detections. The critical sector for both exposure durations extends  $10^\circ$  and  $20^\circ$  from the true posi-

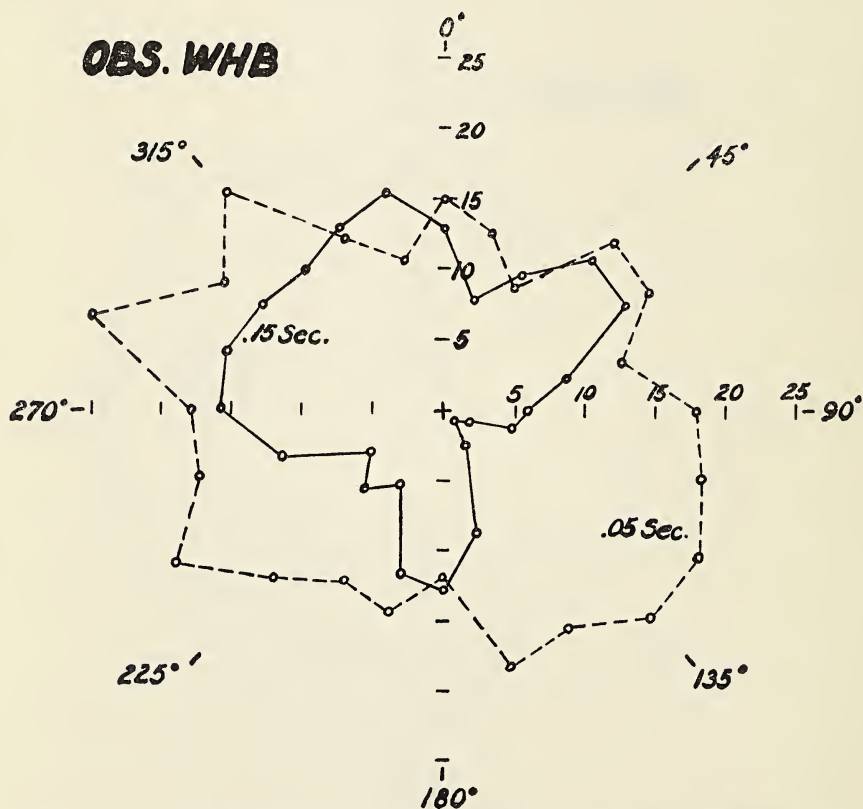


Fig. 3.—Number of "Yes" responses per  $15^\circ$  sectors for Obs. WHB at two exposure durations.

tion for Obs. ERH and WHB, respectively. Consequently, further data-analysis will not include estimation errors greater than  $10^\circ$  for Obs. ERH, or  $20^\circ$  for Obs. WHB.<sup>2</sup>

According to the present argument the localization accuracy with .05-sec. exposures should reflect primarily detection sensitivity, and the .15-sec. data should reflect primarily radial-localization accuracy. Figs. 6 and 7 show frequency of correct localization responses with each duration for Obs. ERH and WHB, respectively. Each data-point represents three adjacent radii, *e.g.*, the  $0^\circ$  sector represents the  $355^\circ$ ,  $0^\circ$ , and  $5^\circ$  radii; etc. The .05-sec. data indicate all responses correct within a critical sector, but the data for .15-sec. exposures indicate only exactly cor-

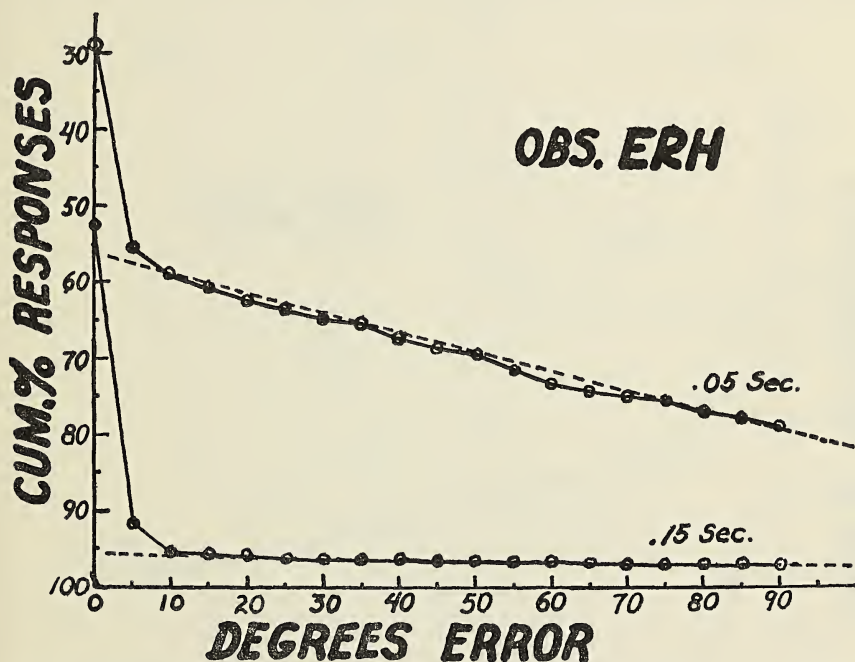


Fig. 4.—Cumulative percentages of responses having increasing magnitudes of error for Obs. ERH.

<sup>2</sup>The localization errors by Obs. ERH with .05-sec. and .15-sec. exposures are given in Tables A and B, respectively. Corresponding data are given for Obs. WHB in Tables C and D. Lettered figures and tables in a 20-page appendix have been deposited with the American Documentation Institute. Order Document No. 7034, remitting \$1.75 for 35mm. microfilm or \$2.50 for 6 by 8 in. photocopies.

rect responses. The .05-sec. contours are, as predicated, oval with the longer axes approximately horizontal. On the other hand, the .15-sec. contours are more irregular with 'fingers' of greater sensitivity. That the two exposures give different results agrees with predictions, but there is some failure of the specific prediction that each of the N, E, S, and W sectors would exhibit greater accuracy than each of the NE, SW, NW, and SE sectors. Although the results of each *O* were consistent, there were large differences between *O*s for localization contours.

For each *O* the data were combined into totals for N, NE, E, SE, S, SW, W, and NW sectors, and then related in a 2 x 2-cell table to the frequencies of correct vs. incorrect responses. Chi-squares were computed for each *O*, and then combined for the two *O*s. For 'detection' (*i.e.*, .05-sec.) data,  $N + S$  vs.  $E + W$  yielded  $\chi^2$  of 43.12 ( $P < .001$ ),

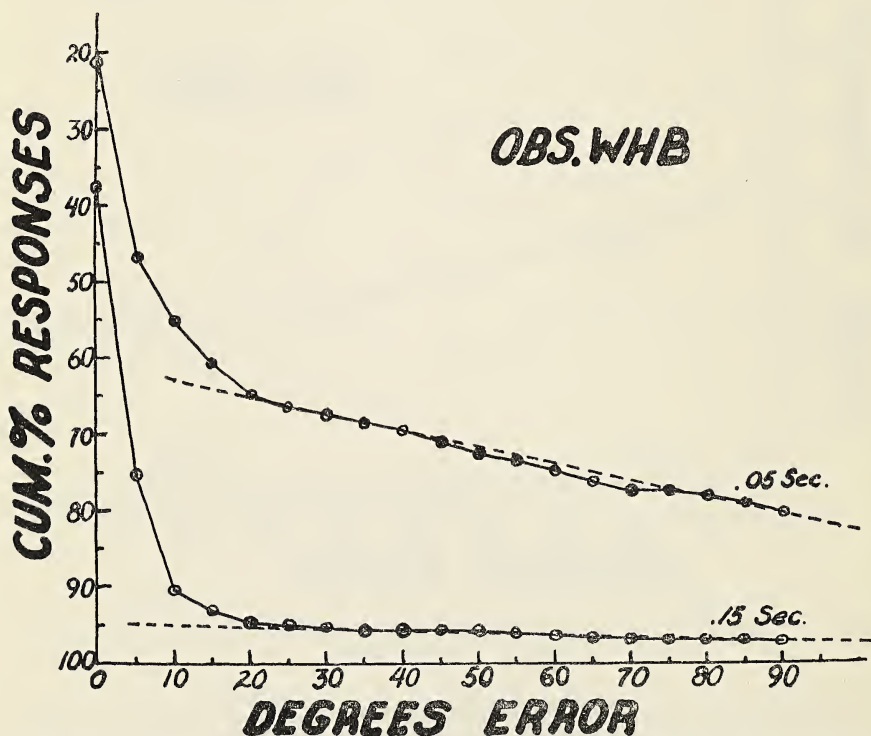


Fig. 5.—Cumulative percentages of responses having increasing magnitudes of error for Obs. WHB.

and the Orthogonals (*i.e.*, N + S + E + W) vs. Diagonals (*i.e.*, NW + SE + NE + SW) produced  $\chi^2$  of 2.62 ( $P > .20$ ). With 'localization' (*i.e.*, .15-sec.) data, however, for N + S vs. E + W the  $\chi^2$  was 6.48 ( $P < .05$ ), and for Orthogonal vs. Diagonal sectors the  $\chi^2$  was 12.93 ( $P < .01$ ). The superiority in localization of the N + S sectors over the E + W sectors was not predicted, but all other predictions were confirmed.

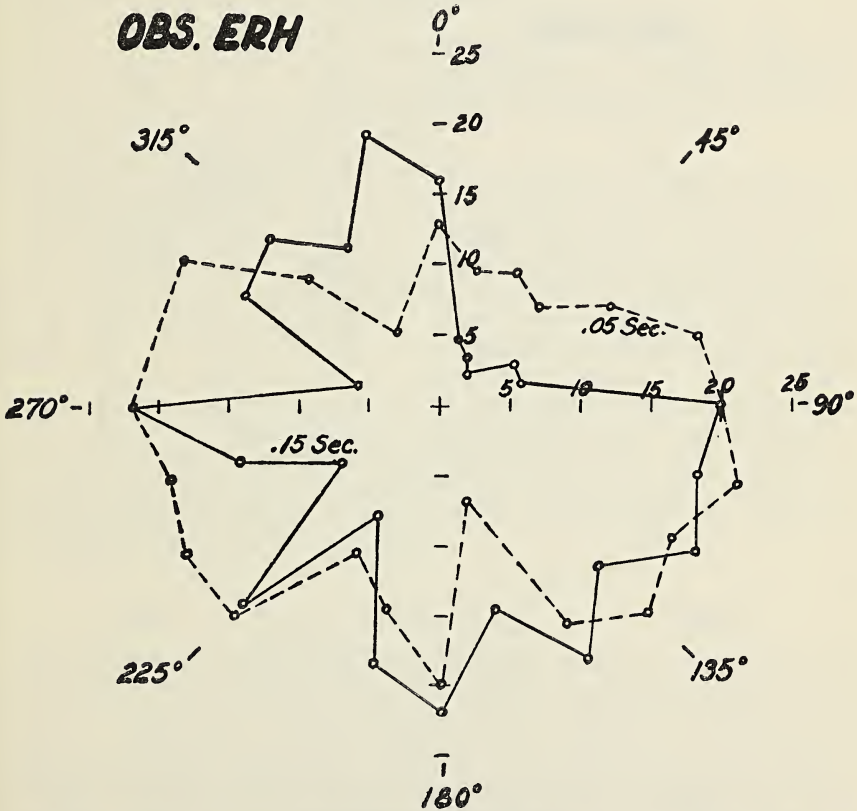


Fig. 6.—Number of correct responses per 15° sectors for Obs. ERH at two exposure durations.



Localization errors were averaged for each O per observation considering the direction (*i.e.*, with sign), and ignoring the direction of the error (*i.e.*, without sign)<sup>3</sup>. Errors within a critical sector—perhaps most valid because of excluding ‘guessing’ errors—are very consistent for each duration for each O, suggesting a constant radial-estimation accuracy for each O. The two Os do differ, however, especially where one or the other O

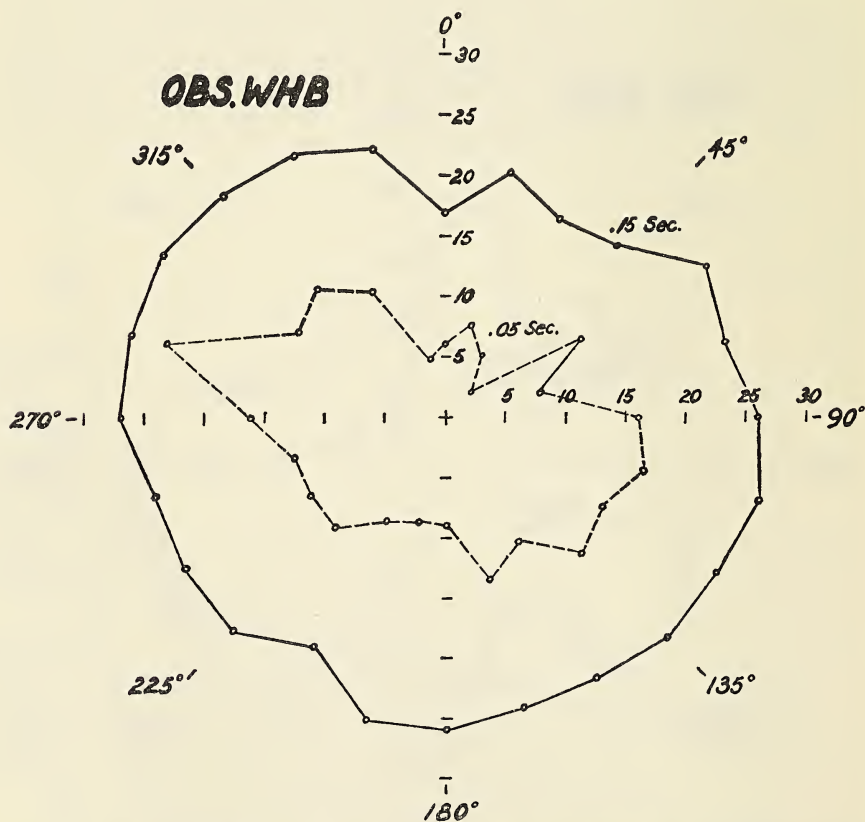


Fig. 7.—Number of correct responses per 15° sectors for Obs. WHB at two exposure durations.

<sup>3</sup>Only responses within a critical sector were used. Clockwise errors were assigned positive values, and counterclockwise errors were considered as negative. Figs. A and B, showing the means of radial-estimation errors computed without regard to sign, and Figs. C and D, showing the means of estimation-errors with regard to sign for Obs. ERH and WHB, respectively, are given in the material deposited with A. D. I.



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departs most from prediction. In spite of the fact that localization is assumed to be related to subjective axes or other subjective reference positions of the visual field, such large individual differences in performance among meridians, while expected, still suggest that more than the two Os are needed in radial-localization experiments.

Mean radial-estimation errors indicate that the Os tended to mis-localize the targets toward the N sector.

### DISCUSSION

Because the frequencies of perfect accuracy for radii with .15-sec. exposures produce irregular radial contours, which are somewhat different for the two Os, one can only say that the data approximated the 'localization' function.<sup>4</sup>

Localization accuracy may be related to subjective horizontal and vertical reference meridians in the visual field. Some support for this comes from Gibson (1934), who reported a negative after-effect upon the perceived orientation of a test figure due to previous looking at a tilted line. Also, Attneave (1955) concluded that Os tended to employ subjective axes of a circular visual field when localizing dots. Something more than the retina is at work here. What it is, makes for interesting speculation. At least we can conclude from the foregoing evidence that the Os' accuracy in reporting the radial position of an eccentric target is dependent upon a minimum of two factors — detection sensitivity and localization accuracy — and these two factors do not produce the same relative accuracy for targets at the various radial positions. Therefore, if one wishes to predict perceptual behavior, one must know the contribution of each factor specifically to the task in question.

### SUMMARY

This experiment distinguishes experimentally between two sources of errors which occur when an observer estimates the radial position of an eccentric target on a simulated radar scope. Failures to perceive the target, as predicted, were most frequent for stimuli above and below fixation, and least frequent for those to the right and left of fixation. Although localization errors tended to be smaller for horizontal and vertical radii, and greater for diagonal radii, these error-contours were irregular, and somewhat specific to the individual O.

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<sup>4</sup>Corroborating evidence has been found in a more recent study employing more Os (Harcum, 1960, Exp. II). Exp. I in this reference is the same experiment as the one described in the present article.

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## ERRATA

Puckett, D. Hugh, L. L. Farmer, and L. R. Emmons, 1961. The Ambulatory Musculature of the Crayfish *Cambarus bartonii sciotensis* Rhoades (1944).

The authors were not given an opportunity to see page proofs for corrections prior to the publication of this paper in The Virginia Journal of Science, Vol. 12(3).

Page 89, line 10, (Rhoades, 1944) should read Rhoades (1944). Line 13, *fluvistilis* should be spelled *fluviatilis*.

Page 90, line 4, (Girard 1852) should read Girard (1852). Line 31, (Figs. II-MRA). should be (Fig. II-MRA).

Page 91, line 31, (Figs. II, V, VI, VII-MP) should be (Figs. II, V, VI, VIII-MP).

Page 92, line 17, (Fig. IV-MDBA) should be (Fig. V-MDBA). Line 18, (Fig. IV-MLBM-B. should be (Fig. IV-MLBM-B). Line 22, (Fig. V-MRM), should be (Fig. IV-MRM), and line 35, (Fig. II-MDBP-C) should be (Fig. III-MDBP-C).

Page 93, lines 14-15, (Figs. I, III) should be (Figs. I, II) and line 16, (Fig. V) should be (Fig. IV).

Page 94, line 1, MDBA-A should be MDBP-A. In Explanation of Figures MADC is *M. Adductor carpopoditis* not *M. Abductor carpopoditis*. MADD is *M. Adductor dactylopoditis* not *M. Abductor dactylopoditis*.

Page 95, the following addition should be made to Explanation of Figures: PC-Posterior condyle.

Page 96, Figure 1, Posterior should be spelled Posterior.

Page 99, Figure V, *M. levator basipoditis posterior* should be *M. depressor basipoditis posterior*.

## News And Notes

*(Editor's Note: News contributions should be sent to the person whose name appears at the end of the appropriate sections.)*

### MESSAGE FROM THE PRESIDENT

Many of us have been planning, since last May, for the 1962 Annual Meetings of the Academy, and it is now time that all of us mark our calendars (May 10-12) and begin to give some thought to what contributions we can make toward the success of these meetings. For years, our Academy has been one of the most active, and, in many ways, one of the most successful of the State Academies. Certainly the heritage and prestige that we enjoy were not derived from a set of coincidences. They are clearly the result of the wisdom, work, and cooperation of the membership.

There are few, if any, scientists in the State who would question the values of our various national meetings and the importance attaching to the attendance and participation in them by Virginians. May I remind you that there are also unquestionable benefits, both to individuals and to our State, which derive from strong Academy meetings. Surely, there is no necessity for enumerating such benefits here.

As you are well aware, the strength and worthwhileness of the Annual Meetings are largely dependent upon the active participation of the members in them, particularly in the Sectional Meetings. I therefore solicit your earnest concern for these sessions and trust that when the call for papers is issued by the sectional secretaries you will not ignore or delay in responding to the requests.

Although it is always dangerous to single out, in advance, any one feature of a group activity as being especially worthy of note, I do not hesitate to call your attention to the Symposium on our Natural Resources which will be held on Thursday, May 10 from 10:00 A.M. to 4:30 P.M. A distinguished panel consisting of scientists from widely scattered parts of the United States has agreed to participate in this discussion which we hope will arouse the interest not only of members of the Academy but also of persons throughout Virginia.

May I take this opportunity to state that no one could have received better cooperation than has your President from his fellow officers, members of the Council, and committeemen. I wish to thank them for all of their efforts and trust that, with your cooperation, we **shall have one**

of the best meetings in the history of the Academy at The Golden Triangle in Norfolk. I shall continue to welcome your suggestions and constructive criticisms.

Sincerely yours,

Horton H. Hobbs, Jr.

#### PRELIMINARY NOTICE OF 1962 MEETING OF THE ACADEMY

The annual meeting of The Virginia Academy of Science will be held in Norfolk, May 10-12, 1962. The host institution will be The Norfolk College of William and Mary. Meetings will be held at The Golden Triangle which is located on Olney Road and Monticello Ave.

The Junior Academy will hold its meetings May 10th at The Golden Triangle. Registration will begin the afternoon of May 9th.

The following advanced information on some of the hotels in the Norfolk area available for the annual meeting is submitted. It will be necessary for each individual to make his reservations direct.

<i>Location</i>	<i>Name</i>	<i>Rates</i>
Downtown	Commodore Maury Hotel	from \$ 6.00
Downtown	Fairfax Hotel	Single from \$ 4.00 Double from \$ 7.00
Downtown	Golden Triangle Motor Hotel	Single from \$10.00 Double from \$14.00
Downtown	Gilbert Hotel	Single from \$ 2.50 Double from \$ 4.50
Downtown	Jefferson Hotel	Single from \$ 4.00 Double from \$ 6.00
Downtown	Monticello Hotel	Single from \$ 5.50 Double from \$ 8.00
Downtown	Thomas Nelson Hotel	Single from \$ 5.00 Double from \$ 7.00
Ocean View	Nansemond Hotel	Moderate

Highway motor courts available are the Admiralty Motor Hotel, Bel-Aire Motel, El Camino Motel, El Rancho Motel, Greenbriar Motel, Hacienda Motel, Holiday Towers Motel, and Howard Johnson's Motor Lodge.  
C. S. Sherwod III, *Norfolk College of William and Mary*

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## AGRICULTURAL SCIENCE

The Nutrition Conference, held November 3-4, 1961 at Virginia Polytechnic Institute was attended by 247 nutritional scientists from 18 states and the District of Columbia. The activity was held in connection with the dedication of the new million dollar Biochemistry and Nutrition Building and in commemoration of the Land Grant Centennial and the 90th anniversary of VPI.

A. L. Eller, Jr., Assistant Extension Specialist in Animal Husbandry at VPI, has been called to active duty in the U. S. Army.

J. A. Gaines, Associate Professor of Animal Husbandry, Virginia Polytechnic Institute, has accepted a 2 year assignment with the FAO. Dr. Gaines will develop an Animal Breeding research program in Argentina.

L. M. Johnson has resigned from the Department of Horticulture at VPI to accept a position as Manager of Production Research with Dulany Foods, Inc.

A grant of \$4,000 has been received from the Virginia State Apple Commission to support research in the Department of Horticulture at VPI on processed apple products.

The following members of the Virginia State Department of Agriculture have been elected to offices in several national societies: W. L. Bendix, President of the U. S. Livestock Sanitary Association; J. W. Middyette, President of the Association of American Seed Control Officials; P. E. Irwin, Secretary of the Association of American Pesticide Control Officials; M. B. Rowe, Executive Committee of the Association of American Fertilizer Control Officials.

Entomologists from VPI who attended the recent Baltimore meetings of the Eastern Branch of the Entomological Society of America were C. H. Hill, C. B. Dominick, M. L. Bobb, A. M. Woodside, E. C. Turner, and J. M. Grayson. Dr. Grayson served as Chairman of the Society for 1961.

Recent additions to the VPI Department of Plant Pathology and Physiology are C. W. Le Fevre, S. W. Bingham and V. P. Sterrett. R. H. Hurt, a member of the department for 39 years, has recently retired. — Paul B. Siegel, *Virginia Polytechnic Institute*.

## ASTRONOMY, MATHEMATICS AND PHYSICS

The V. M. I. Physics Department with the assistance of a grant of \$24,000 from the AEC has assembled a sub-critical reactor which is expected to be in operation by the first of 1962. — D. Rae Carpenter, Jr., *Virginia Military Institute*.

# Quality



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## PSYCHOLOGY

The semi-annual meeting of the Virginia Psychological Association was held in Richmond on October 20th. After a full day of business, largely devoted to discussion of the report of the legislative committee on proposed changes in the state certification law for psychologists, social hour, and banquet, the invited address was given by Dr. Ogden Lindsley, Director of the Behavior Research Laboratory, Harvard Medical School, Metropolitan State Hospital, Waltham, Massachusetts.

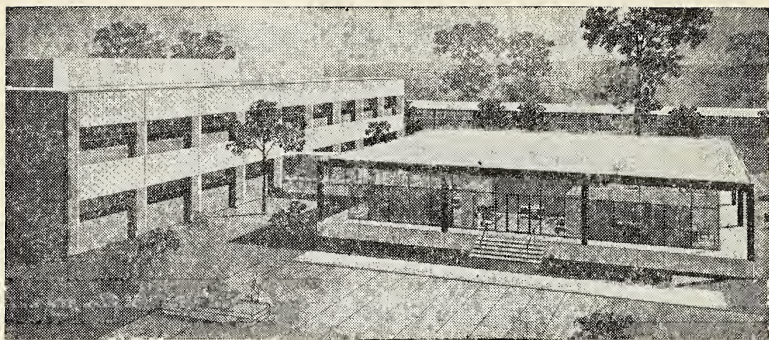
Dr. Lindsley spoke on "Experimental Analysis of Behavior of Chronic Psychotics." Dr. Lindsley's presentation of his longitudinal research on operant conditioning of long-term psychotic patients provided considerable interest in the methodological and theoretical problems confronted, and produced a lively audience response. The VAS Psychology Section chairman, Dr. Robert Johnston of U. of R. was among the more vigorous discussants.

Charles L. Fry, Jr. joined the Psychology Department at the University of Virginia in June. He is a recent Ph.D. from the University of Rochester. Dr. Fry's research and instructional interests are principally in social and developmental psychology.

University of Virginia psychologists were active in the meetings of the Psychonomic Society and the American Psychological Association in New York in September. Frank W. Finger, professor of psychology and president of Division 1 of the American Psychological Association, delivered the presidential address to the division of general psychology. William F. Battig, associate professor, delivered a paper on "Transfer from Verbal-Discrimination to Paired-Associate Learning" to the Psychonomic Society. At the American Psychological Association meetings he was chairman of a paper session on "Concept-Formation" and of a discussion session on "Verbal Learning." Frank A. Geldard, professor of psychology and dean of the Graduate School of Arts and Sciences, chaired a session on "Physiological Psychology" at the Psychonomic Society meetings and L. Starling Reid, professor of psychology and Head of the Department, University of Virginia, chaired a session on "Human Learning." — Frederick B. Rowe, *Randolph-Macon Women's College*.

## BIOLOGY

On July 1, 1961, the School of Marine Science of the Colleges of William and Mary replaced the Department of Marine Science of the College of William and Mary. Dr. William J. Hargis, Jr., was named as Dean. The degree offered at this time is the Master of Arts in Marine Science



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The Department of Biology, Randolph-Macon Woman's College, has acquired 50 acres of forested land to be known as the William Buford Russell and Robert Achilles Russell Nature Preserve. This was obtained by partial purchase from and donation by Mr. W. B. Russell. The tract is located 12 miles from the campus and will be used for student and faculty study and research. Dr. Dorothy Crandall and Dr. James Chamberlain have been working during the past summer on a three year forest ecological study of the Piedmont area. Particular attention is being directed toward plant succession and small mammal populations.

Dr. Franklin F. Flint has been appointed Acting Chairman of the Biology Department at Randolph-Macon Woman's College.

Dr. Lyman R. Emmons, a graduate of Trinity College, who received his Ph.D. degree from the University of Virginia, has been appointed Assistant Professor of Biology at Washington and Lee University.

Mr. Joe E. Coggins, formerly with the Educational Division, Virginia Commission of Game and Inland Fisheries, has been appointed to the staff of the Biology Department at Hampden-Sydney College.

Dr. R. H. Hoffman, Biology Department, Radford College, conducted studies during the summer of the millipede fauna of the southeastern Appalachians under a grant from N.S.F. This grant was administered by the Highlands Biological Station.

Dr. Mary E. Humphreys, Mary Baldwin College, attended a N.S.F. Summer Institute for college teachers of botany at Washington State University.

The Department of Biology at the University of Virginia have three post-doctoral fellows. They are: Richard White, Ph.D. Washington University, 1961; Justo de la Pax, Ph.D. Cornell University, 1957; R. George Babcock, Ph.D. University of Virginia, 1961.

Dr. W. Ralph Singleton, Miller Professor of Biology and Director of the Blandy Experimental Farm, has completed a textbook entitled *Elementary Genetics* which will appear in publication next May. Its chief illustrator is Dr. Te-Hsiu Ma, Assistant Professor of Biology at Emory and Henry College.

Dr. Louis R. Hundley, Virginia Military Institute, attended an eight week Summer Institute in Radiation Biology at Tulane University. Dr. Hundley has also received a three year research grant from the U. S. Public Health Service for the sum of \$30,079 to work on the changes in

the chemical composition of bone and muscles due to exercise and fat loads.

Dr. John R. Reaves, Jr., V.M.I., worked last summer as a naturalist for the Blue Ridge Parkway at the Peaks of Otter.

Dr. Jesse C. Thompson, Jr., Hollins College, has received a three year grant from N.S.F. totaling \$14,700 to support research dealing with the morphology and taxonomy of two orders of ciliated protozoa. Dr. Thompson spent this past summer at the School of Marine Science in Gloucester Point, Virginia. Later he presented a paper at the First International Conference on Protozoology in Prague, Czechoslovakia and visited laboratories in Hungary, Italy, France and England. — Jesse C. Thompson, Jr., *Hollins College*.

#### STATISTICS SECTION

The Department of Statistics at the Florida State University will expand its graduate program to study and research leading to the Doctor of Philosophy degree in statistics. Dr. R. A. Bradley, formerly of Virginia Polytechnic Institute, is head of the department. One of his staff is Dr. R. G. Cornell who received his Ph.D. degree at Virginia Polytechnic Institute.

A joint meeting of the Virginia Academy of Science Chapter of the American Statistical Association and the Richmond Chapter of the American Society for Quality Control was held November 18, 1961, at Waynesboro, Virginia. Four papers were presented to the thirty-one individuals attending.

Clyde Y. Kramer of the Department of Statistics, Virginia Polytechnic Institute has been elected chairman of the Biometrics Section of the American Statistical Association. He will also serve as program chairman for the Section and Biometrics Society for the 1962 annual meeting.

Mr. Whitney L. Johnson will join the Statistics Department at Virginia Polytechnic Institute as Associate Professor on January 1, 1962. Mr. Johnson has a B.S. from Utah State University, a M.S. from University of Minnesota and is now completing his Ph.D. requirements at the University of Minnesota. — Clyde Y. Kramer, *Virginia Polytechnic Institute*.

THE ANNUAL SUBSCRIPTION RATE is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Carl W. Allen, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

### NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Paul B. Siegel, Virginia Polytechnic Institute, Blacksburg, Virginia. If any preliminary notes have been published on the subject which is submitted a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8 1/2" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscript into subheadings must follow a consistent plan. It is desirable that a brief summary be included in all manuscripts.

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Explanation of graphs and tabular material should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be indicated at the appropriate place in the margin.

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## HIGHER EDUCATION IN VIRGINIA<sup>1</sup>

R. W. ENGEL

*Virginia Agricultural Experiment Station  
Blacksburg, Virginia*

Our educational system is under attack (*Public Education Under Criticism*, Prentice-Hall Inc., New York, 1954). Evidence that this was the case appeared long before the recent movement into outer space (Scott and Hill, 1954). Some idea of how criticisms have mushroomed to alarming proportions can be seen if one looks at the entries in the educational index under the heading of "public schools-criticism." For the period 1942 to 1952 entries increased from 3 to 49.

These criticisms have exerted an influence in the general direction of stiffening curricula, increasing emphasis in mathematics and science, and special attention for the gifted. Mrs. Rollin Brown, president of the National Congress of Parents and Teachers with a membership of nearly 11,000,000 says the stress will be on better counseling guidance rather than on the "crash program" recommended by some critics. (New York Times, April 27, 1958).

There is also an increasing trend at college level in the direction of more basic science in the curricula of departments of instruction in agriculture (Agronomy, Animal Husbandry, Dairy, etc.). It is my sincere hope that emphasis in this direction will not disrupt too seriously the present program of training agricultural technologists. Seventy-five years of such training through the land-grant colleges has produced the most abundant and efficient agricultural production and product-processing system in the world, one which is envied by all other countries. This is an impressive record. I do wish to emphasize, however, that this entire program would benefit greatly if quality of instruction could be upgraded at all levels in our educational system.

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<sup>1</sup>This paper was presented before the Agricultural Science Section at the 1958 meeting of The Virginia Academy of Science.

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We often assume that many of our agricultural students in the land-grant college system are ill-prepared for college studies because of over-emphasis on technological rather than academic courses in high school. I don't know whether the record will support this assumption. I have reviewed the records of 38 randomly selected students who entered as freshmen in the school of agriculture at V. P. I. in the fall of 1957. The record reveals that 71 per cent of these students enrolled in at least one unit in agriculture in high school and that 40 per cent finished high school with 4 units in agriculture. It is also true, however, that 87 per cent of these students satisfactorily completed one unit of biology, that 68 per cent completed one unit of high school chemistry, and that 50 per cent of them completed 3 units of high school mathematics. Much more difficult to evaluate, of course, is the quality of instruction. Based on the performance of these students in college chemistry or mathematics courses, one must conclude that there is perhaps less fault to be found with high school curricula than with the subject matter actually taught. If motivation is a major factor in developing future scientists, it is doubtfully achieved when the high school teacher is proficient in the teaching skills but deficient in knowledge of subject matter taught.

Recent movements into space have stirred many people to the realization that accomplishments in technology rest upon the productivity of our educational institutions. Discussion of satellites and "what's wrong with our educational system?" appear to be almost inseparable in the minds of people who have been stirred by recent events.

Traditionally, our institutions of higher learning are a reflection of the aspirations, the desires, the aims, and the problems of the American people. We turn to colleges and universities for leadership when new resources are to be explored, when emergencies arise, or when we have the inclination to effect improvements in agriculture or industry. Perhaps it is hardly worth even to mention that the nature of institutions of higher learning in a free society could represent anything other than the aspirations of the citizens acting in an atmosphere of freedom.

If we accept this reasoning, it becomes evident that an institution of higher learning will or will not flourish, depending upon the citizens from which its support is derived, whether it be a public or a private institution. Why have some institutions flourished and others not? Is this question in any way related to, "Why are some states rich in agricultural and industrial development and others poor?" If we accept the thesis that the amount of support received from the citizenry of an institution will reflect its usefulness or productivity, I think we would have to agree that material wealth is very likely a product of a sound program of education at all levels.

In line with this thinking there is naturally the question as to where



we stand in Virginia. If we accept the basic assumption that every American child should be educated to the highest level that his inheritance and interests will reasonably allow, and if we accept the study reported by the Iowa investigators (Hughes and Lancelot, 1946), we learn that Virginia ranks thirty-fourth among the 48 states in ability to support education. Hughes and Lancelot summarize Virginia as follows, "Despite its illustrious past and its numerous famous sons, it does not appear to value public education highly." It is further stated that, "Virginia stands in forty-second position as to all-around educational performance. The record as a whole is not at all creditable." These authors further suggest that federal aid to education must be provided if the children of Virginia are to have a fair chance to secure an education of the kind that our times demand.

As a citizen of Virginia, I am quite frankly chagrined at the record for which I must assume a share of responsibility. Why does my state with its impressive record of illustrious sons rank so poorly in providing public education for its citizens, and what can I do to improve its position?

I believe that higher education as a functional entity of our society is not well understood by the public generally. All of our citizens should be made to understand that virtually all the important differences between man ten thousand years ago and man today are due to education. All of our citizens should be made aware of the fact that higher education must accomplish three goals to be successful and to enrich its citizens. These are to dispense knowledge in the life sciences, in the physical sciences, and in the social sciences and humanities. It is not easy for the average citizen to comprehend what we mean when we speak in terms of the humanities and insist that education in the humanities has something to do with preparing for a career in agriculture. Perhaps this will become clearer if we speak in terms of what is involved in adjusting our lives to the truth, which is another definition for education. Approached in this way, perhaps the average citizen can comprehend the function of higher education. Adjusting our lives to the truth, involves (1) learning about life (biological sciences) (2) learning about the physical world in which life is supported (physical sciences) and (3) learning the relationships of living beings to each other and to the world in which they are supported (social sciences and humanities).

Today it is manifestly impossible for one individual to become proficient in more than one specialized field of knowledge. Division of labor, even among intellectual skills, is therefore necessary. Someone has recently remarked, "The sordid truth is that the fellowship of educated man has become increasingly to resemble a zoo, with each of us duly labeled chemist or poet, or economist, or agronomist, or what not, blatantly

parading his uniqueness in his appropriate cage." These divisions are established for temporary convenience but unfortunately often tend to become permanent.

Many scientific disciplines must be brought to bear, for example, if we are to expect any real new knowledge to be applied in agriculture (genetics, biochemistry, biophysics, embryology, endocrinology, etc.). For persons of many different intellectual interests to work in unison toward a common goal requires an appreciation of the relationship of living beings to each other. Since this involves humanities as we have defined them, their importance becomes self-evident. Another way of stating it is that successful cooperation in research is dependent upon the proper attitude of mind. Proper attitudes of mind are developed as a consequence of man's knowledge of himself in relation to others.

Let's assume that we can find the means of convincing the supporting citizenry that more vigorous support of education, including higher education, is essential for the state of Virginia. What will we do with this new support? I am going to develop some rather simple thoughts which I hope will convince you as to how we can most efficiently use additional support.

It has often been said that the only way a student can acquire the ability to think is to be associated with a teacher who thinks. The better thinker the teacher is, the better chance the student has of approaching higher levels in his own thinking. The farther the student advances, the greater the demand upon the teacher to continue to advance.

This student-teacher relationship in thought processes is brought to its highest level in the graduate school. To this extent the graduate school is largely responsible for stimulating scholarship at all levels of higher education. Until we have support for developing graduate schools in which this student-teacher relationship can flourish, it is foolhardy to assume that any real advances in higher education can be expected in Virginia.

Realistic financing of graduate programs must allow flexibility in teaching loads so the teacher has time for scholarly advancement, or, to return to the simpler terminology just developed, give the teacher time to think. Gardening as a hobby and gardening as an economic necessity for college professors are quite distinct, and let's face the fact that when gardening is done of economic necessity, its influence on thought processes as they are transmitted to the student may not have the most desirable effects.

Many of you may not agree with me, but it is my belief that rich industrial or agricultural states have gotten that way because they sup-

ported education generously, and that this generous support enriched the lives of the citizens because the highest scholarly attainment, namely graduate studies, were given special emphasis.

I find no serious fault with continuing our philosophy of education based on the aspirations of the citizens of a free society. This system has produced 35 Nobel prize winners whereas the system of educational regimentation which produced the Sputniks has produced only 2 Nobel prize winners. What does concern me, however, is that none of the Nobel prize winners in science, produced by our educational system, came from Virginia or from any of our neighboring southern states.

I have urged that more adequate support for higher education in Virginia needs particular attention. This view is strongly supported by recent data (Folger and Sugg, 1956). These authors point out that the southern region of the United States grants 27 per cent of the nation's bachelor's degrees but only 13 per cent of its doctor's degrees.

Virginia, with a past rich in illustrious statesmen, must be reawakened to the realization that the desire to teach and the desire to learn are qualities which ultimately determine whether her citizens prosper or decay. This is neither speculation nor prophecy; rather it is a simple statement of man's achievements throughout recorded history.

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## NEW OSTRACODS OF THE GENUS ENTOCY THERE FROM THE MOUNTAIN LAKE REGION, VIRGINIA (Ostracoda, Entocytheridae)

HORTON H. HOBBS, JR. and MARGARET WALTON

*Mountain Lake Biological Station, University of Virginia*

Among the entocytherid ostracods of the Mountain Lake region are two undescribed species which are associated with the burrowing crayfish, *Cambarus carolinus* (Erichson). One of them, *Entocythere asceta*, appears to infest only this crayfish, and hence is confined to a subsurface habitat. The other, *E. chalaza*, which is much more abundant, is found on the same crayfish, and only on one occasion was it found on another; thus it too seems to be largely restricted to one host and to subsurface groundwaters. A third undescribed species, *E. phyma*, somewhat closely related to *E. asceta*, has been found on three species of crayfishes in several epigeal lotic habitats in the area.

*Entocythere chalaza* is a member of the Runki Group (Crawford 1959: 157), and *E. asceta* and *E. phyma* are here assigned to a new group, the Asceta Group, along with *E. cyma* Hobbs and Walton (1960: 18).

All descriptions of the male copulatory complexes are based on those in the copulatory attitude; i.e., those in which the clasping apparatus is directed anteriorly.

### ASCETA GROUP (Here Designated)

*Diagnosis.*—Terminal tooth of mandible with cusps; maxillary palp with two terminal and no dorsal setae. Copulatory complex with a well developed or reduced finger guard. Peniferum extending ventrally much beyond clasping apparatus, elongate, slender, entirely corneous with subterminal bulbous enlargement containing the penis; accessory groove lacking; clasping apparatus without distinct teeth on either internal or external border but with three to five teeth near or at distal extremity. Females of *E. asceta* without an amiculum; females unknown in *E. cyma* and *E. phyma*.

### KEY TO THE SPECIES OF THE ASCETA GROUP

The Asceta Group is here erected to receive the previously described *Entocythere cyma* Hobbs and Walton and two species, *E. asceta* and *E. phyma*, described below.

- 1 Peniferum with distal extremity bulbous or broadly tapering



- (figs. 5 and 11) ..... 2
- 1' Peniferum with distal extremity in the form of a mesially-curved, finger-like projection (fig. 1) *Entocythere asceta*, sp. nov.
- 2(1) Distal extremity of peniferum bulbous; distal half of penis spiculiform and strongly curved; clasping apparatus reduced in size with from one to five denticles distally.....  
*Entocythere phyma*, sp. nov.
- 2' Distal extremity of peniferum swollen but elongate; distal half of penis never spiculiform; clasping apparatus prominent, with distal fluted expansion bearing five denticles .....  
*Entocythere cyma* Hobbs and Walton

*Entocythere asceta*,<sup>1</sup> sp. nov.

*Male*.—Shell (fig. 3) subovate with a shallow ventral emargination slightly anterior to midlength; maximum height slightly posterior to midlength. Marginal setae widely, but evenly, dispersed except dorsally.

See Table I for measurements.

Copulatory complex (figs. 1 and 4) with peniferum heavily sclerotized and comparatively slender but with a prominent subterminal bulbous expansion; ventral surface of bulbous portion with a tapering conical projection, its slender tip directed mesially; base of conical projection with a mesially situated, oblique (anteroproximal to posterodistal), rectangular phalange with its posterodistal border bent mesially. Penis, situated in bulbous expansion, prominent, strongly curved, and its distal portion guarded by a tooth-like projection. Dorsal finger slender and of the usual type; ventral finger, also slender, strongly bent with extensions of the two ends forming about a 60° angle. Finger guard reduced to a small sclerotized plate proximolateral to the bases of the two fingers. Clasping apparatus (fig. 4) strongly curved but not clearly divisible into vertical and horizontal rami; external border entire; internal border with two shallow emarginations in distal fourth; distal extremity with three or four denticles.

*Female*.—Shell of triunguis female (fig. 2) either markedly similar to that of male, or more frequently with a scalloped posteroventral margin. Amiculum and J-shaped rod absent, but posterodorsal area with a small posterodorsally directed tubercle partially surrounded by an amorphous, but usually approximately the same shaped, mass. See Table I for measurements.

<sup>1</sup>Ascetis, G.—curiously wrought; so named because of the ornate distal portion of the peniferum.

*Type Locality and Range.*—Crayfish burrows on golf course of the Mountain Lake Hotel off Virginia Route 700, approximately nine miles N. E. of Pembroke, Giles County, Virginia. The host is *Cambarus carolinus* (Erichson), the only crayfish with which this species has been found associated. Additional localities include (1) the nearby Mountain Lake Biological Station grounds; (2) crayfish burrows along Middle Creek, 1.2 mi. N. of Maggie, Craig Co., Va., on Rte. 636; and (3) burrows along a tributary of Rays Branch, 2.0 mi. S. E. of Waiteville, Monroe Co, W. Va., on Rte. 15.

*Disposition of Types.*—The holotypic male, the allotypic female and paratype males are deposited in the United States National Museum. Paratype males are in the collections of E. A. Crawford and C. W. Hart, Jr. Both male and female paratypes are in the collection of the senior author.

*Relationships.*—*Entocythere asceta* is most closely related to *E. cyma* and *E. phyma*. The bulbous distal portion of the penifera of the three are markedly similar; ecologically, however, *E. asceta* is distinct, for it is found only on a burrowing crayfish while the other two occur on crayfishes frequenting lotic habitats. In its apparent restricted host and habitat, and in the elongate peniferum, it approaches the two members of the Geophila Group, *E. geophila* Hart and *E. torreya* Hart (1959: 195, 198).

*Entocythere phyma*,<sup>2</sup> sp. nov.

*Male.*—Shell (fig. 10) subovate with margins entire; maximum height slightly posterior to midlength. Marginal setae very sparse anteriorly, ventrally, and posteriorly; absent dorsally. See Table I for measurements.

Copulatory complex (figs. 11, 12, and 13) with peniferum heavily sclerotized and comparatively slender but with a prominent terminal bulbous expansion. Prominent penis, situated in bulbous expansion, tapering to a long spiculiform process which frequently extends beyond distal extremity of peniferum. Dorsal finger slender; ventral finger, also slender, gently curved throughout its length. Finger guard prominent, slender, and rounded distally. Clasping apparatus proportionally smaller than that of any other known entocytherid (and more variable than any known to the authors) and so loosely articulated with the peniferum as to be directed as much as 180° from the usual position (that illustrated in fig. 11 is bent at about 45°). Clasping apparatus always curved and frequently not divisible into vertical and horizontal rami; apex may be expanded (figs. 11 and 13) and bear as many as five denticles, or it may be tapering (fig. 12) and bear one to three denticles.

<sup>2</sup>Phyma, G.—tumor or tubercule; so named because of the swollen distal portion of the peniferum.

No specimens of *E. phyma* have been found in copula and it has not been possible to associate a female with the male.

*Type Locality and Range.*—White Rock Branch, 6.7 mi. N. of the Mountain Lake Biological Station on Rte. 613, Giles County, Virginia (.5 mi. S. of junction with Rte. 635). The hosts are *Cambarus b. bartonii* (Fab.) and *C. b. sciottensis* Rhoades. In Laurel Branch, a tributary of Big Stony Creek, .6 mi. E. of Rte. 635 on Rte. 628, and at the Cascades on Little Stony Creek, Giles Co., Va., it was found on the same hosts. In Dicks Creek, 2.2 mi. from jct. of Rtes. 636 and 658 in Craig Co., Va., it was found associated with *C. b. bartonii*.

*Disposition of Types.*—The holotypic male is deposited in the United States National Museum. Parotypic males are in the collections of E. A. Crawford, C. W. Hart, Jr. and the senior author.

*Relationships.*—*Entocythere phyma* has its closest affinities with *E. cyma* Hobbs and Walton (1960: 18) and is somewhat more distantly related to *E. asceta*. It may be distinguished, however, from both by the much smaller clasping apparatus and the terminal (not subterminal) bulbous condition of the peniferum.

*Entocythere chalaza*,<sup>3</sup> sp. nov.

*Male.*—Shell (fig. 6) subovate with margins entire; maximum height slightly posterior to midlength. Submarginal setae rather close together anterodorsally and posteriorly, but sparse ventrally; none on dorsal margin. See Table I for measurements.

Mandible with terminal tooth bearing cusps. Maxillary palp with the usual two recurved terminal teeth.

Copulatory complex (figs. 8 and 9) with peniferum usually heavily sclerotized and robust and with a conspicuous hump, or swelling, on posterodistal portion. Apical end of peniferum directed anteriorly. Penis of moderate size and situated at level of finger guard. Accessory groove present and extending proximally to loop of spermatic duct. Dorsal finger slender and with a single long seta; ventral finger curved throughout so that apex is directed anterodorsally. Finger guard prominent, strongly arched anteriorly, bifid distally with the larger posterior element directed posteroventrally. Clasping apparatus divisible into vertical and horizontal rami. Vertical ramus strongly curved and gradually broadens distally so that its maximum width occurs at junction with horizontal ramus, the thickest portion of the clasping apparatus. Horizontal ramus with external border entire and slightly convex; internal border with one prominent

<sup>3</sup>Chalaza, G.—a hard lump; referring to the caudal swelling on the posterodistal position of the peniferum.



angular elevation slightly proximal to midlength; apex of clasping apparatus without distinct denticles but marked by two longitudinal grooves which extend posteriorly on lateral surface of horizontal ramus.

*Female*.—Shell of triunguis female (fig. 7) essentially similar to that of male but frequently with a shallow ventral emargination just anterior to midlength, and often with a posteroventral lobular expansion. Prominent J-shaped rod and ruffled amiculum present. See Table I for measurements.

*Type Locality and Range*.—Identical with that of *Entocythere asceta* (which see) except a single male was found in a collection of *Cambarus b. bartonii*, *C. l. longulus* Girard, and *C. montanus acuminatus* Faxon in a small tributary to the North Fork of the Roanoke River, .2 mi. N. E. of junction of Rtes. 785 and 723, on the former, Montgomery Co, Va.

*Disposition of Types*.—The holotypic male, allotypic female, and male and female paratypes are deposited in the United States National Museum. Paratypes are in the collections of E. A. Crawford, C. W. Hart, Jr. and the senior author.

*Relationships*.—*Entocythere chalaza* is a member of the Runki Group and closely allied to *E. daphnioides* Hobbs (1955: 325), *E. runki* Hobbs (1955: 330), *E. mecoscapa* Hobbs and Walton (1960: 19), *E. suteri* Crawford (1959: 162), and *E. chelomata* Crawford (1961: 242). It shares with all of these the presence of a finger guard, at least one tooth on the internal border of the clasping apparatus, and an amiculum in the female. The males of *E. chalaza* may be distinguished by the thickened angle of the clasping apparatus and the single "tooth" on its internal border.

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#### EXPLANATIONS OF FIGURES

(Figs. 2, 3, 6, 7, and 10 drawn to Scale 1; Figs. 1, 5, 8, and 11 to Scale 2; and Figs. 4, 9, 12, and 13 to Scale 3.)

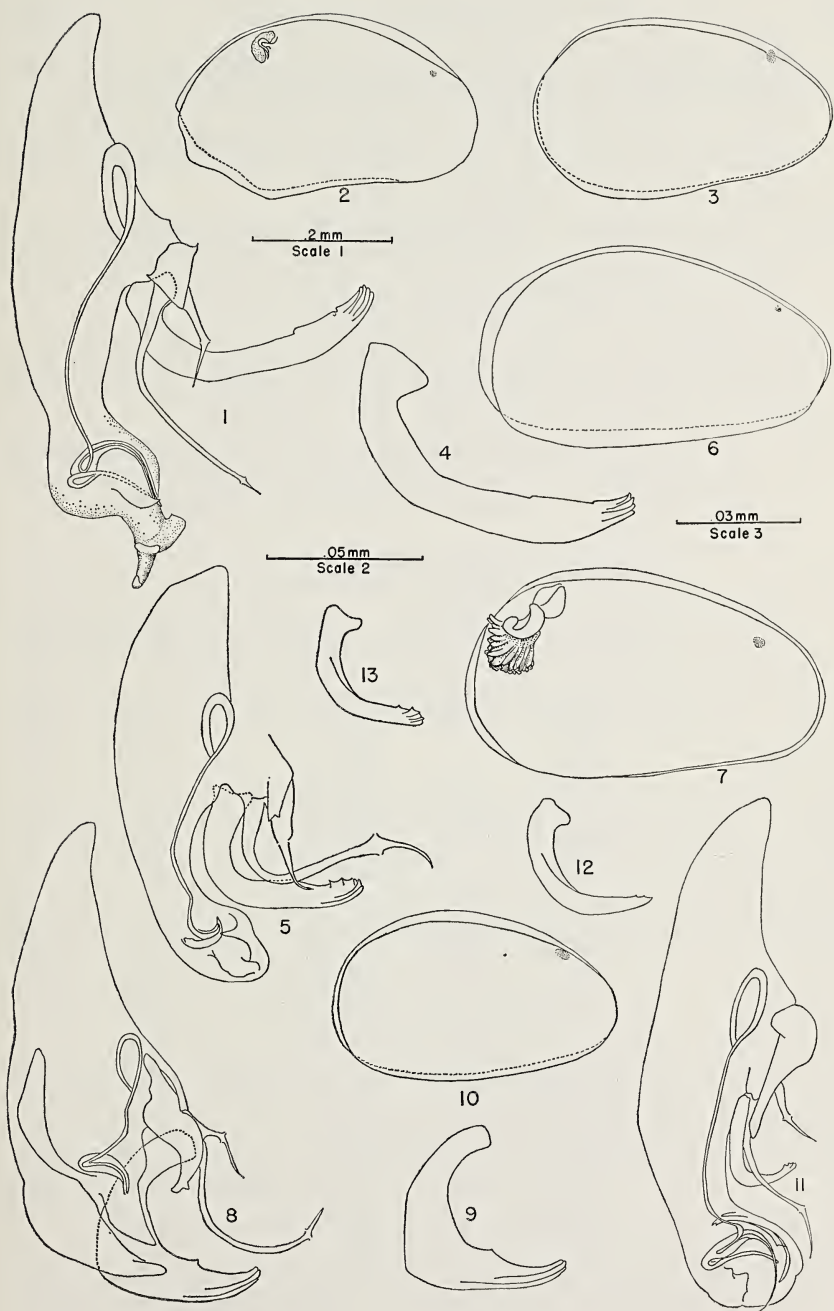
Figs. 1-4—*E. asceta*, sp. nov. 1. Copulatory complex of male; 2. Shell of triunguis female; 3. Shell of male; 4. Clasping apparatus of male.

Fig. 5—Copulatory complex of male of *E. cyma* Hobbs and Walton.

Figs. 6-9—*E. chalaza*, sp. nov. 6. Shell of male; 7. Shell of triunguis female; 8. Copulatory complex of male; 9. Clasping apparatus of male.

Figs 10-13—*E. phyma*, sp. nov. 10. Shell of male; 11. Copulatory complex of male; 12, 13. Clasping apparati of males showing variation.





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Table 1.—Measurements (in mm.)

	Sex	Length		Height		Length/Height	
<i>E. asceta</i>							
Mean	♂	.416±	.00894*	.237±	.00707	1.76±	.0433
Minimum	♂	.405		.225		1.68	
Maximum	♂	.430		.250		1.80	
Mean	♀	.428±	.00141	.253±	.00141	1.69±	.0432
Minimum	♀	.425		.250		1.63	
Maximum	♀	.435		.260		1.74	
<i>E. phyma</i>							
Mean	♂	.382±	.0122	.219±	.00244	1.75±	.0713
Minimum	♂	.375		.210		1.63	
Maximum	♂	.410		.230		1.83	
<i>E. chalaza</i>							
Mean	♂	.451±	.0105	.259±	.0141	1.74±	.0627
Minimum	♂	.430		.250		1.63	
Maximum	♂	.470		.280		1.84	
Mean	♀	.463±	.0134	.276±	.00894	1.68±	.0402
Minimum	♀	.430		.255		1.61	
Maximum	♀	.475		.285		1.74	

\*Standard deviation

## ACADEMIC PREDICTION USING SCHOLASTIC, PERSONALITY AND INTEREST FACTORS

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### THE PROBLEM AND ITS SETTING

The prediction problem considered in this paper is to determine which applicants for entrance in a certain college are best suited for that college.<sup>1</sup> Correlation techniques have been widely used in making academic predictions for about forty years. Many such studies have been made (Pierson, 1958) and at the present time new studies are currently underway (Henderson and Masten, 1959; Holland, 1958; Pierson, 1958). Thus the problem is an old and important one.

In their excellent review of work on academic prediction, Chauncey and Fredericksen (1951) pointed out that a plateau seems to have been reached using multiple regression techniques with academic predictions. It was their feeling that other factors of a psychological nature such as motivation, emotional stability, and interests must be considered if significant improvements are to be made. Limited studies using such factors have been done in the past (Chauncey and Frederickson, 1951; Maier, 1957).

The study which is partially described in this paper was quite broad in that it involved thirty-one predictor variables including eleven academic, ten personality, and ten interest factors. The dependent variable or criterion was academic success during the freshman year of college as measured by the quality point average. The study was conducted at the College of William and Mary in Norfolk using 419 members of the freshman class entering in September of 1957.

The predictor variables used are as follows:

1. *A High School Quality Point Average*, devised and computed for this study from information taken from the high school transcripts ( $x_1$ ).
2. *Cooperative School and College Ability Test* (SCAT), published in 1956 by the Cooperative Test Division of the Educational Testing Service in Princeton, New Jersey ( $x_2, x_3, x_4$ ).
3. *Diagnostic Reading Test, Survey Section*, Form B, published in

<sup>1</sup>Part of a study submitted to the School of Education, University of Virginia in partial fulfillment of requirements for Doctor of Education degree.

1947 by the Committee on Diagnostic Reading Tests ( $x_5, x_6, x_7, x_8$ ).

4. *English Training* test, Form M in the new series (revised) of the Iowa Placement Examinations, published in 1941 by the Bureau of Educational Research and Services ( $x_9, x_{10}, x_{11}$ ).

5. *Kuder Preference Record, Form CH*, published in 1948 by Science Research Associates ( $x_{12}$  to  $x_{21}$ ).

6. *Guilford-Zimmerman Temperament Survey*, published in 1949 by the Sheridan Supply Company ( $x_{22}$  to  $x_{31}$ ).

*Criterion.* The dependent variable or criterion was the College Quality Point Average. This average for each subject was obtained from official records of the College.

## PROCEDURE AND ANALYSES OF RESULTS

*Procedure.* Multiple regression analysis techniques were used. Most of the computations were carried out by means of automatic computing equipment (IBM 650 System).

*Results.* The results are summarized in Tables I, II, and III.

Table I gives the multiple correlation coefficient and its related variance analysis. From it we see  $F(31/387) = 3.1447/.2530 = 12.43$ , which is significant well beyond the .01 level.

An  $R^2$  of .50 (rounded from .4989) indicates that approximately 50 per cent of the variability of the sample group in College QPA's can be accounted for by the predictor variables used in the study.

Table II presents the matrix of simple correlations between each of the thirty-two variables in the study. The first row indicates the correlation between the criterion — College Quality Point Average — and each of the thirty-one predictor variables.

In Table III, the coefficients of the multiple regression equation are entered. The  $b_i$  are the coefficients of  $x_i$  variables in the regression equation. The third column, labeled  $V_{b_i}$  gives the variance of the regression coefficients. The next column, labeled  $F$ , lists the variance ratio.

*Analysis of Results.* The prediction ( $R = .71$ ) of College QPA is obtained by using the multiple regression equation for all thirty-two variables

given here in deviation form:  $y = \sum_{i=1}^{32} b_i x_i$ .

However, it would not be feasible to use this equation in practical pre-



diction problems. The arithmetic involved would far exceed the precision obtained. A multiple correlation close to .71 can be obtained by using only a fraction of the total number of variables. To illustrate, multiple correlations were computed using:

(1) the five variables with statistically significant  $b_i$ 's in the multiple regression equation (see Table III). An  $R$  of .62 was obtained.

(2) Next the five variables having the highest simple correlations with the criterion were used (see Table II) giving an  $R$  of .67.

(3) Finally a combination of the first two groups was used ( $x_1, x_2, x_{23}, x_{11}, x_4$ ) giving an  $R$  of .68 which, although containing only five variables, is rather close to the total  $R$  of .71. Thus a multiple correlation close to .71 can be obtained from far less than the total number of variables. It is interesting to note those variables which survived the partialing out effects in a multiple regression analysis involving all of the variables were not necessarily the best predictor variables in the smaller battery.

It is also interesting to note that the individual predictive value of a particular variable, when highly correlated with the criterion, may be highly significant when taken alone or with one or two other selected variables. The  $x_2$  variable has a non-significant  $b_2$  in the regression equation. However,  $x_2$  is highly correlated with  $y$ , and taken alone accounts for about 20 per cent of the variance of College QPA's. Further,  $x_2$ , when combined with  $x_1$ , yields a multiple correlation,  $R_{y(x_1, x_2)} = .66$ .

Some comment should be made regarding the significant variables in the equation. Table III reveals that  $x_1$ , (High School QPA) and  $x_2$  have predictive value, which is significant at the .01 level. Two others,  $x_{15}$  (Scientific Interest Test of the Kuder Preference Index) and  $x_{23}$  (Impulsiveness-Restraint Index of the Guilford-Zimmerman Survey), have  $b_i$ 's significant at the .05 level. Several others are close to conventional significance, such as  $x_{28}$  (Hostility-Friendliness Index of the Guilford-Zimmerman Survey), which is significant at the .10 level.

It is not surprising to find that the most highly significant single predictor of college standing is high school grades ( $x_1$ ). The HSQPA's independent contribution is also highly significant. None of the other variables which are highly correlated with the criterion such as the SCAT ( $x_2, x_3, x_4$ ), Reading Test ( $x_5, x_6, x_7, x_8$ ), and English Test ( $x_9, x_{10}$ ) made independent contributions in the multiple regression equation which were statistically significant. Perhaps part of the reason for the relatively high correlation between HSQPA and CQPA ( $r = .60$ ) and the highly significant  $b_i$  in the equation is due to the localized nature of the study.

About 86% of the sample came from sixteen high schools located in the Greater Hampton Roads Area which would tend to make the student body at William and Mary in Norfolk more homogeneous than in most colleges. High schools in a given locality tend to offer work of similar kind and quality and also tend to grade in similar ways.

The Subjectivity-Objectivity Index ( $x_{27}$ ) of the Guilford-Zimmerman Temperament Survey has a low but statistically significant positive correlation with the criterion ( $r = .13$ ). In the equation,  $b_{27}$  is also significant at the .01 level. Students who score high on this item are more objective, which is interpreted to mean "thickskinned" and not hypersensitive, self-centered, or suspicious by nature.

One explanation of the survival of  $x_{27}$  in the regression equation may be found in the fact that the correlation between HSQA and  $x_{27}$  is not significant; whereas the correlation between CQPA and  $x_{27}$  is significant. This indicates that college teachers place a higher value on the so-called "objectivity" of the Guilford-Zimmerman Survey than do high school teachers and that college teachers allow this to be reflected in their grading.

In the equation,  $b_{15}$  is significant at the .05 level. Variable  $x_{15}$  is the raw score made on the Scientific Interest Index. The correlation between  $x_{15}$  and both HSQA and CQPA is slightly negative and not significant. The fact that  $b_{15}$  is negative indicates that a scientific interest would be associated with lower grades. Variable  $x_{15}$  seems to be a "suppressor," since it is not significantly correlated with the criterion but is correlated with  $x_2, x_3, x_1, x_6, x_7, x_8,$  and  $x_9$  (all significant at the .01 level) and with  $x_{10}$  (significant at the .05 level); whereas all of the latter variables are significantly correlated (at the .01 level) with the criterion.

Perhaps the reason a scientific interest ( $x_{15}$ ) is correlated with neither high school nor college grades is due to the fact that  $x_{15}$  is positively correlated with some variables associated with good grades ( $x_2, x_3, x_4, x_6, x_7, x_8$ ), but negatively correlated with other variables associated with good grades ( $x_9, x_{10}$ ). These may have a canceling out effect so far as correlation with grades is concerned.

The Impulsive-Restraint Index ( $x_{23}$ ) has a coefficient in the multiple regression equation which is statistically significant at the .05 level. There is a low positive correlation (significant at the .01 level) between  $x_{23}$  and both HSQA and CQPA. Restraint, as here used, is a measure of a serious-minded, deliberate, persistent effort (i.e., self-control) as opposed to a happy-go-lucky, carefree, impulsive effort.

A partial explanation for the statistically significant  $b_{23}$  can be found

in the fact that  $x_{23}$  has a statistically significant correlation with only eleven of the thirty-one predictor variables. This indicates that the variable should have a more independent contribution to make to the prediction of CQPA. To put it another way, one would say that the Impulsive-Restraint Index is measuring something contributory to good grades that most of the other variables (a notable exception being HSQPA) are not measuring.

None of the other variables have statistically significant coefficients in the regression equation. This may be somewhat surprising especially with regard to those variables highly correlated with the criterion. There are perhaps two reasons for this result; (1) the large number of predictor variables; and (2) the sample size in relation to the number of variables.

The first of the two reasons given above is by far the more important. Generally, in multiple regression analysis, the more variables used, the higher the multiple correlation obtained. However, in psychological data, it is difficult to get a large number of different measures of a single individual which do not show considerable intercorrelation. This is especially true when many of the variables are obtained by multiple evaluations of the same responses on test items with each evaluation yielding a new variable. Thus, no new information is being added but new variables are being added and the effect is to spread out among many variables the fixed amount of variance accounted for. This results in a lowering of the effectiveness of all. This can be illustrated using  $x_2$  and  $x_4$ , which are parts of the same test.

$R^2_y(x_1) = .36$  and  $R^2_y(x_1, x_2) = .434$  indicating that the addition of  $x_2$  increased the amount of variability accounted for by 7.4 per cent. Similarly,  $R^2_y(x_1, x_4) = .431$ , indicating that the addition of  $x_4$  to  $x_1$  brought an increase of 7.1 per cent; however,  $R^2_y(x_1, x_2, x_4) = .440$ , indicating that the addition of  $x_4$  to  $x_1$  and  $x_2$ , brought an increase of only 0.6 per cent. Thus either  $x_2$  or  $x_4$  could separately account for about 7 per cent of the variability, but when both are combined, they account for only 8 per cent, or an "average" of 4 per cent per variable added. In this study, the large number of inter-correlated predictor variables used resulted in much spreading out of the variability accounted for.

The second explanation for the large number of non-significant variables is more of a cure than a cause. Because of the effects described above, it is essential it use very large samples when a large number of predictor variables is being used. The sample size ( $N = 419$ ) used in this study, is quite large. It would not be at all unreasonable, however, to use a sample several times this size when so many variables are considered.



## CONCLUSIONS

The results indicate that the best individual predictor in the study is high school grades ( $r = .60$ ). For a reasonably good substitute, the SCAT score ( $r = .47$ ) or the English Training Test score ( $r = .49$ ) are also good individual predictors.

The best combination of two scores would be HSQPA and the verbal score of SCAT which give an  $R_y(x_1, x_2)$  of .66. The best combination of five scores would be HSQPA, the verbal score of SCAT, Impulsive-Restraint Index score of the Guilford-Zimmerman Survey, the English Training Examination score, and the total score of SCAT. This combination gives an  $R_y(x_1, x_2, x_{23}, x_{11}, x_4) = .68$  which is very close to the maximum of .71.

In addition to these statistical findings, the study seems to carry certain general implications for college entrance policy. These are listed in rough order of importance.

*First*, it would seem that in selection, more significance should be given to the high school grades of applicants to the college. The study reaffirms the conclusion, often found, that good grades in high school are the best single indicator of good grades in college.

*Second*, for selection purposes, the use of the SCAT and the English Training Examination seem to be amply justified as the scores on these tests are reasonably good predictors of College QPA. Perhaps the use of a combination of all of these academic predictors would be best with a major emphasis on high school grades.

*Third*, so far as selection is concerned, the personality survey and interest index as a whole do not seem to be highly effective. Such tests are very valuable and interesting in a multiple regression analysis, however,

TABLE I  
ANALYSIS OF VARIANCE

	$R = .7063$	$R^2 = .4989$	
	SS	V	d.f.
REGRESSION	97.4847	3.1447	31
ERROR	97.9085	.2530	387
TOTAL	195.3932		418
	$(31/387) F = \frac{3.1447}{.2530} = 12.43$		$P \text{ at } .01 = 1.84$



TABLE II

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29	X30	X31
Y	.60	.45	.33	.47	.19	.15	.32	.29	.36	.43	.49	-.00	-.11	-.07	-.04	-.19	.07	.17	.09	.04	-.03	-.05	.18	.04	.00	.05	.13	.10	.12	.13	-.16
X1		.32	.80	.37	.22	.12	.27	.25	.40	.50	.52	-.03	-.28	-.13	-.05	-.23	.10	.18	.13	.16	.02	-.01	.12	-.04	-.01	.05	.05	.14	.07	.14	-.29
X2			.42	.84	.44	.35	.59	.62	.45	.45	.52	.15	.05	-.05	.15	-.17	.02	.26	.01	-.12	-.16	-.04	.02	.04	-.15	-.01	.05	-.04	.09	.08	.10
X3				.83	.22	.32	.49	.41	.25	.28	.31	.17	.29	.34	.25	-.18	-.16	-.00	-.15	-.17	-.08	.20	.06	.10	.01	.11	.07	.01	.07	.07	.26
X4					.39	.40	.64	.60	.43	.44	.50	.18	.20	.17	.22	-.21	-.08	.15	-.08	-.17	-.13	.09	.04	.08	.03	.08	.06	.07	.03	.09	.08
X5						-.01	.52	.29	.44	.20	.22	.04	-.13	-.03	.01	-.07	.03	.24	.00	-.03	-.02	.16	-.03	.09	.03	.03	.02	-.08	.05	-.04	.02
X6							.26	.75	.01	.10	.19	.18	.25	.10	.19	-.09	-.04	.02	-.11	-.18	-.10	-.02	-.04	-.04	-.15	.02	.05	-.04	.00	.08	.25
X7								.52	.50	.38	.40	.12	.04	.01	.16	-.14	.09	.17	.02	-.16	.16	.11	-.02	.12	-.00	.08	.02	-.11	.14	.05	.11
X8									.25	.26	.33	.21	.18	.03	.22	-.13	-.00	.10	-.10	-.19	-.16	.03	.02	.02	-.12	.03	.05	-.06	.04	.09	.22
X9										.48	.41	-.04	-.26	-.16	-.13	-.08	.07	.24	.15	.07	.01	.13	-.02	.05	.08	.01	-.04	.00	.07	.03	.22
X10											.64	-.03	-.18	-.17	-.10	-.19	.12	.13	.20	.12	-.01	-.02	.08	-.06	-.00	-.01	.00	.10	.04	.07	.24
X11												.03	-.15	-.17	.00	-.23	.08	.16	.12	.03	-.06	.12	.07	-.04	-.04	-.04	.05	.09	.03	.12	-.18
X12													.43	-.10	.46	-.50	.03	-.16	.26	.06	-.51	-.03	.06	-.14	-.22	-.01	.05	.02	.05	.01	.32
X13														.27	.49	-.22	-.12	-.36	-.40	-.39	-.30	.02	-.06	-.10	-.17	.03	.05	-.10	-.05	.00	.58
X14															.30	-.06	-.36	-.09	-.26	-.37	.36	.10	-.01	-.02	-.09	.06	.06	-.12	.01	-.06	.36
X15																-.37	-.30	-.25	-.40	-.14	-.36	.01	.08	-.06	-.18	.04	.10	-.09	.07	-.01	.46
X16																	-.12	.03	.06	.24	.03	-.14	.26	.19	.03	-.05	.10	-.07	-.03	.02	
X17																		-.04	.11	-.10	-.14	-.18	-.04	-.16	-.06	.03	-.00	.09	-.03	.09	.20
X18																			.22	-.17	.02	-.01	.08	.15	-.02	.03	-.05	-.06	.14	-.02	.13
X19																				.01	-.06	-.03	-.01	.15	.12	-.13	-.07	-.01	.07	-.06	.33
X20																					-.15	.01	.18	.01	.18	.04	.03	.26	.03	.05	-.39
X21																						.00	-.09	.13	-.01	-.04	-.07	-.02	-.12	-.01	.17
X22																						.08	.42	.46	.16	.07	-.02	.18	.10	.07	
X23																								.20	.23	.27	.31	.47	.40	.34	.03
X24																									.63	.30	.21	.01	.29	.10	.06
X25																										.35	.27	.23	.20	.23	-.18
X26																											.63	.42	-.11	.33	.14
X27																												.57	-.06	.53	.17
X28																													.04	.55	-.60
X29																													.23	.10	.20
X30																															
X31																															

TABLE III  
MULTIPLE REGRESSION EQUATION COEFFICIENTS

i	$b_i$	$V_{bi}$	F	Level of Significance*
1	.4851	.0030	79.734	beyond .01
2	.0464	.2597	.008	not significant
3	.2919—	.2273	.375	not significant
4	.9328	.6860	1.268	not significant
5	.1300—	.0123	1.370	not significant
6	.0279—	.0203	.038	not significant
7	.0448	.0194	.104	not significant
8	.0315—	.0357	.028	not significant
9	.1253	.0175	.899	not significant
10	.0048—	.0157	.001	not significant
11	.2193	.0182	2.636	not significant
12	.1480—	.0735	.298	not significant
13	.3066	.1042	.902	not significant
14	.0721	.1685	.031	not significant
15	.6593—	.1013	4.291	.05
16	.1699—	.0836	.345	not significant
17	.0951—	.1307	.069	not significant
18	.1067—	.1791	.064	not significant
19	.2950—	.2274	.383	not significant
20	.0996—	.0882	.113	not significant
21	.1449—	.0978	.215	not significant
22	.8771—	.3325	2.313	not significant
23	1.4156	.3836	5.224	.05
24	.3756	.5342	.264	not significant
25	.0558—	.4136	.008	not significant
26	.8189—	.4580	1.464	not significant
27	2.1244	.4537	9.948	.01
28	1.1379—	.4340	2.984	.10
29	.5985	.3667	.977	not significant
30	.1222—	.3701	.040	not significant
31	.7038—	.3892	1.273	not significant

\*  $F(1,300) = 3.87$  at .05 level and  $= 6.76$  at .01 level

as has been shown. On an individual student basis the academic measures are a much better predictor of college grades nonetheless.

*Fourth*, in exception to the above conclusion, one of the personality traits stands out — the Impulsive-Restraint Index. This would seem to single out and emphasize that a serious-minded, deliberate, persistent effort (i.e., self-control) as opposed to a happy-go-lucky, impulsive, care-free attitude is quite important in attaining good grades.

By way of a final summary, the one main conclusion of the study is:

The High School QPA is highly predictive of College QPA, but other variables — mostly academic but also including certain personality characteristics — serve to improve somewhat the prediction of college success.

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## News And Notes

*(Editor's Note: News contributions should be sent to the person whose name appears at the end of the appropriate sections.)*

*Change of address notification* should be sent promptly to Carl W. Allen, Managing Editor, Virginia Journal of Science, Virginia Polytechnic Institute, Blacksburg, Virginia. Give both old and new addresses.

### 1962 MEETING OF THE ACADEMY

The Fortieth Annual Meeting of the Virginia Academy of Science will be held in Norfolk in May. Information on some of the hotels in the area was given in the January issue. The Program of the meeting may be found in this issue.

### MINUTES OF THE COUNCIL MEETING

Newcomb Hall, University of Virginia, November 19, 1961

The meeting was called to order by President Horton H. Hobbs, Jr., at 10:05 A.M., 19 November 1961, with the following members present:

Carl W. Allen, Wilson B. Bell, Walter S. Flory, Susie V. Floyd, J. C. Forbes, P. Arne Hansen, E. S. Harlow, Boyd Harshbarger, William M. Hinton, Horton H. Hobbs, Jr., Henry Leidheiser, Jr., G. Tyler Miller, Jr., Lawrence R. Quarles, Stuart B. Row, E. V. Russell, Jr., C. S. Sherwood, III, Paul B. Siegel, Foley F. Smith, Edgar Winston Spencer, Jackson J. Taylor, Edward F. Turner, Jr., Stanley Williams.

President Hobbs as the first order of business, offered his resignation to Council due to the fact that he had accepted a position as Curator of Zoology at the National Museum in Washington, D. C. It was moved, seconded and unanimously passed that his resignation not be accepted.

President Hobbs advised the Council that he had officially represented the Academy at the inauguration of the new President of the College of William and Mary; and at the dedication of the new Biochemistry and Nutrition Building at the Virginia Polytechnic Institute.

The resignation of Dr. Robert Ross, as Editor-In-Chief of the *Virginia Journal of Science*, was accepted, along with the resignation of Mrs. Mary Ross as Business Manager. Dr. Boyd Harshbarger reported for the committee appointed to select a new editor and business manager for the Journal. He moved the appointment of Dr. Paul B. Siegel of the Virginia Polytechnic Institute, as Editor, and the appointment of Dr. Carl

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Allen, also of the Virginia Polytechnic Institute as Business Manager. This motion was seconded, and the appointments were unanimously approved.

President Hobbs acknowledged a gift of \$2,500 from an anonymous member of the Academy. The income and annual interest from the investment of this amount is to be used for the expenses of the guest speaker at the annual meeting. It was moved, seconded and passed, that the gift be accepted for the Academy, and that the President write the donor extending grateful appreciation and thanks for this bequest. It was moved, seconded and passed that this be turned over to the trustees for investment to provide the income for the honorarium, and travel expenses of a guest speaker.

The Treasurer made a brief report concerning the funds of the general account of the Academy, and the funds contained in the research account. He reported all outstanding bills paid, and that the annual billing for 1962 would be made early this year.

Dr. Walter Flory made a comprehensive report for the Long Range Planning Committee. This was a printed report and was distributed to each member of the Council. Among the items contained in this report were the following:

That membership application information be publicized in the *Virginia Journal of Science* and the annual Academy leaflet.

The Treasurer reported that the revised leaflet galley proofs had been corrected, and that the revised leaflet was in press.

It was pointed out that the Constitution would be printed in the *Virginia Journal of Science* in 1962, and would be subsequently published in the January issue of the Journal, in the years divisible by five.

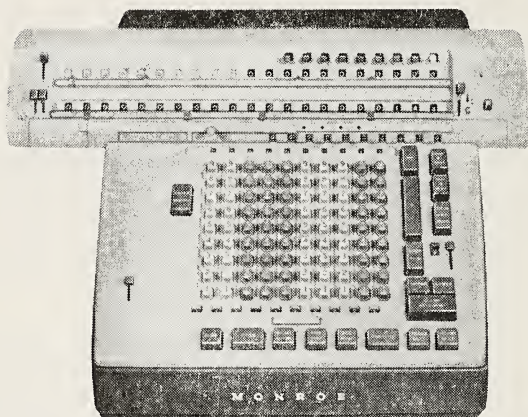
The proposal of three members of the Academy concerning the selection of meeting places was rejected.

It was moved, seconded and passed, that the recommendations of the Long Range Planning Committee be accepted.

After discussion it was moved, seconded, and passed, that another recommendation of the Committee concerning the appointment of a new committee, the Natural Resource Committee, be accepted; and that the Resource Use Committee not be appointed after this year. The new committee is to be appointed by the President to begin work after the annual meeting in 1962.

It was moved, seconded and passed, that the officers of the Academy be directed to investigate appropriate ways in which the Virginia Academy






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of Science might encourage the improvement and expansion of student loan funds by the Commonwealth of Virginia.

Dr. Henry Leidheiser reported on the Symposium on Natural Resources to be held on Thursday at the next annual meeting in Norfolk. It was moved, seconded and passed, that the Symposium be held on Thursday, 10 May 1962, from 10 to 6 p.m. This Symposium would concern six main subjects: Soil, Forest, Coal, Marine Life, Water and People.

The President was instructed to inform the Chairman of the Science Teachers Section that there is no money available for the expense of a guest speaker for a specific section.

Mr. C. S. Sherwood III, Chairman of the Local Committee for Arrangements for the next annual meeting, reported tentative arrangements to date. The Golden Triangle Motel is to be headquarters for the Senior Academy, and the Junior Academy exhibits will be held in the Norfolk Arena three blocks away. Tours are tentatively arranged for the Naval Station, Back Bay Wild Life Refuge, and the Langley Research Center.

Mr. Edward S. Harlow reported for the Membership committee and noted that the committee on Business membership has been active and contacts have been made.

Miss Susie Floyd reported for Dr. Scott concerning the activities of the Junior Academy. This year it was decided that no "Science Days" would be held, and that students would be screened on the basis of submitted papers, and would be invited to the meeting on such basis. It was further decided that there would be no sponsored social activities for the Junior Academy.

Dr. John Forbes reported for the Visiting Scientists Program. He said that there were no further funds available from the National Science Foundation, for such a program. He reported that it might be possible to secure funds for a Junior Academy program. It was moved, seconded and passed, that the Visiting Scientists Committee be discharged with the grateful thanks of the Council.

Mr. E. V. Russell, Department of Chemistry, Virginia Polytechnic Institute made a brief report on the work of the Science Talent Search Committee.

There was no report for the Flora, Scholarship, Resource-Use, or History of Science Committees. President-Elect Jackson Taylor reported on his attendance at the Teachers and Science Education meeting in Washington, D. C.

Dr. Stanley Williams as chairman of the committee appointed to study the problems of setting up a permanent Executive Secretary's office



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reported; and commented on the background of the project, cost, possible sources of money, and possible personnel. He recommended that the study be continued.

The President reported that Dr. Baldwin of William and Mary College had advised him that the Dismal Swamp project was four fifths completed and results would be forthcoming. A motion was made, seconded and passed, that the President write Mr. Baldwin thanking him for his efforts, and inviting him to conduct a field trip through the Dismal Swamp at the Norfolk meeting.

It was moved, seconded and passed, that the President write the Committee for the Engineering and Scientist's Dinner, held annually in the Richmond area; that the Virginia Academy of Science was sympathetic with the aims of the group, but could not sponsor or help underwrite the dinner since the Academy was a Statewide organization, and could not show partiality for a local organization.

It was moved, seconded and passed, that Council adopt a resolution received from the Biology Section of the Academy commending the Old Dominion Foundation, the Virginia Department of Conservation and Economic Development, and Governor Almond for their initiation of "an acquisition program of specific natural areas for the Commonwealth, including the safeguarding of such unique lands as the Ware Marsh and Bone and Wreck Islands on Virginia's Eastern Shore . . ." and copies of this resolution be distributed to the appropriate persons.

At the suggestion of the Treasurer, it was moved, seconded and passed, that the annual registration fee be raised to \$1.00, except for student members who would pay half price; and that the reason for the existence of the registration fee be explained in the annual program, as general information for the Academy membership.

It was suggested that the Chairman of the Academy Trustees should be a member of Council, and that the Flora committee be discharged. Both of those suggestions were tabled at this time.

It was moved, seconded and passed, that a committee be appointed to study the possibility of awards and citations that might be made to industrial firms of the State, who have made outstanding contributions to science.

After discussion, it was decided that the Academy should make an outright gift to the Building Fund of the Virginia Institute for Scientific Research; and that the Council should authorize a letter to the Academy membership, inviting them to contribute to this Fund as individual members. It was moved, seconded and passed, that the Academy donate \$200

for this Fund, and also advance another \$800; this advance to be repaid from contributions received as result of the above request. The Treasurer was authorized to draw a check for \$1,000 covering these two items, and this check was presented to Dr. Leidheiser. It was further understood that any individual contributions so received in excess of \$800, would also go to the Institute.

It was moved, seconded and passed, that the Council authorize an audit of the books of the *Virginia Journal of Science*, in order to turn them over the new Editor and Business Manager.

The meeting adjourned at 3:00 P.M.

Foley F. Smith, Secretary pro tem



# Virginia Academy of Science

## *Program*

OF THE  
Fortieth Annual Meeting  
NORFOLK, VIRGINIA



May 9-12, 1962

HOST TO MEETING

Norfolk College Of William And Mary

# Virginia Academy of Science

## OFFICERS

Horton H. Hobbs, *President*

Jackson J. Taylor, *President-elect*

Paul M. Patterson, *Secretary*

Foley F. Smith, *Treasurer*

William B. Wartman, Jr., *Assistant Secretary-Treasurer*

## LOCAL COMMITTEE ON ARRANGEMENTS

*General Chairman:* C. S. Sherwood, Chemistry Dept., Norfolk College  
of William and Mary

*Registration:* Margaret C. Phillips

*Housing:* R. Messmer

*Junior Academy:* J. M. Long

*Commercial Exhibits:* A. K. Clark

*Meeting Rooms and Equipment:* C. L. Adams

*Information and Transportation:* J. C. Zaneveld

*Field Trips:* W. Harrison

*Publicity:* Dorothy Lippencott

*Signs and Maps:* L. H. Miller

*Traffic and Parking:* W. M. Beck

*Special Dinners and Luncheons:* Rebecca O. White

*Entertainment for Ladies:* Jane N. Byrn

# General Program Of The 40th Annual Meeting

GOLDEN TRIANGLE HOTEL

EXHIBITS — EAST BALLROOM

WEDNESDAY, MAY 9

- 1:00 p.m. to 8:30 p.m. Registration and Arrangement of Exhibits, Virginia Junior Academy of Science (VJAS). Mezzanine.
- 7:00 p.m. VJAS Committee Meeting. Room 800-801.
- 7:30 p.m. Meeting of the Council. Robert E. Lee Room.
- 8:30 p.m. VJAS Lecture, Science Education in India and the Far East, by I. D. Wilson. West Ballroom.

THURSDAY, MAY 10

- 8:00 a.m. Registration, Lobby. Exhibits, East Ballroom.
- 9:00 a.m. Virginia Science Talent Search Interviews. Rooms 605, 612, 621 and 628.
- 9:00 a.m. Concurrent Sessions of VJAS. Biology, Camellia Room; Chemistry and Biochemistry, Azalea Room; Physics and Engineering, Dogwood Room; Mathematics and Astronomy, Suite 700-701; Earth Sciences, Suite 600-601.
- 9:30 a.m. Symposium on Basic Research on Virginia's Natural Resources. West Ballroom. See detailed section of the program.
- 2:00 p.m. Meeting of the Council. Robert E. Lee Room.
- 2:00 p.m. Section of Science Teachers. Room 800-801.
- 2:00 p.m. to 4:30 p.m. Concurrent Sessions of VJAS. See above.
- 4:30 pm. Meeting of Section Editors. Robert E. Lee Room.
- 6:00 p.m. VJAS Committee Meeting. Suite 700-701.
- 7:30 p.m. VJAS Business Meeting and Lecture. Camellia Room.
- 8:00 p.m. Annual Academy Conference. West Ballroom.

## FRIDAY, MAY 11

- 8:00 a.m. Registration, Lobby. Exhibits, East Ballroom. Section meetings. See detailed section of the program.
- 12:30 p.m. to 1:30 p.m. VJAS Awards Hour. Camellia Room.
- 1:30 p.m. VJAS Committee Meeting. Room 801.
- 4:30 p.m. to 6:00 p.m. Tea for all members of the Academy, their wives and husbands. Hughes Library, The Norfolk College of William and Mary, 48th Street.
- 8:00 p.m. Virginia Academy of Science Assembly. West Ballroom. Short Business Meeting. Election of Officers. Presentation of the J. Shelton Horsley Research Award. Guest Speaker.

## SATURDAY, MAY 12

- 8:00 a.m. Section meetings.
- 10:00 a.m. Meeting of the Council. Room 700.



## SYMPOSIUM ON BASIC RESEARCH ON VIRGINIA'S NATURAL RESOURCES

*Sponsored by The Virginia Institute for Scientific Research  
and  
The Virginia Academy of Science*

THURSDAY, MAY 10

WEST BALLROOM

- 9:30 Welcome and Introduction.  
Dr. Henry Leidheiser, Jr., Director, Virginia Institute for Scientific Research.
1. 9:35 Coal.  
Dr. Gilbert Thiessen, Assistant to Vice President, Koppers Company, Pittsburgh, Pennsylvania.
- 10:30 Break
2. 10:40 Soils.  
Dr. A. Geoffrey Norman, Professor, Botany and Director, Botanical Gardens, University of Michigan, Ann Arbor, Mich.
3. 11:35 Forests.  
Dr. George H. Hepting, Chief, Division of Forest Disease Research, Southeast Experiment Station, U. S. Forestry Service, Asheville, North Carolina.
- 12:30 Lunch
4. 2:00 Water.  
Dr. John C. Frye, Chief, Illinois Geological Survey, Urbana, Illinois.
5. 2:55 Marine Life.  
Dr. J. Laurence McHugh, Chief, Division Biological Research, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Washington, D. C.
- 3:50 Break
6. 4:00 People.  
Dr. Clarence C. Little, Scientific Director, Tobacco Industry Research Committee, New York City.

*For additional information contact:*

Dr. Russell J. Rowlett, Jr.  
Virginia Institute for Scientific Research  
2820 Grove Avenue  
Richmond 21, Virginia

## Section Of Agricultural Science

FRIDAY, MAY 11--8:20 A.M.

JEFFERSON ROOM

- 8:20 Call to order by Chairman. Announcements and Committee Appointments
1. 8:30 Insect Resistance to Insecticides in Virginia.  
James McDonald Grayson, Department of Entomology, VPI
  2. 8:45 Gross Morphology of a Sting Nematode in Virginia.  
Betty J. Gray and Lawrence I. Miller, Virginia Agricultural Experiment Station, Holland, Virginia
  3. 8:57 Response of Tobacco Hornworm Moths to Selected Bands of Radiant Energy.  
J. M. Stanley and U. F. Earp, Agricultural Engineering Department, VPI
  4. 9:12 Anion Retention by Virginia Soils.  
Grant W. Thomas, Agronomy Department, VPI
  5. 9:27 Soil and Water Conservation Needs of Virginia.  
J. K. Abernathy, Soil Conservation Service, Richmond, Virginia
  6. 9:42 Machine Monoliths Show Why Soils Are Different.  
George C. Willson, Jr., Soil Conservation Service, Richmond, Virginia  
Earl H. Brunger, Soil Conservation Service, Charlottesville, Virginia
- 9:57 Intermission
7. 10:10 Making Use of Electronic Computer Equipment to Evaluate Fertilizer Manufacturers in Control Program.  
Arthur T. Hart, Virginia Department of Agriculture, Richmond, Virginia
  8. 10:25 Fertilizer Distribution Patterns From Bulk Spreader Trucks.  
Floyd M. Cunningham, Agricultural Engineering Department, VPI  
Maurice B. Rowe, Virginia Department of Agriculture, Richmond, Virginia
  9. 10:40 Physiological Aspects of Quackgrass Control.  
H. M. LeBaron, Virginia Truck Experiment Station, Norfolk, Virginia

10. 10:55 A. Trial Use of Salt Water River Sediment as a Mulch on Some Vegetable and Ornamental Plants.  
M. M. Parker, Virginia Truck Experiment Station, Norfolk, Virginia
11. 11:10 Adaptation of Coastal and Midland Bermudagrass in Southeastern Virginia.  
D. L. Hallock, Tidewater Research Station, Holland, Virginia
12. 11:25 Lime or Fertilizer for Alfalfa—Which Is Critical?  
W. W. Moschler, Department of Agronomy, VPI
13. 11:37 Survival of the Cysts of *Heterodera glycines* adhering to Stored Sweetpotato, Peanut, and Peanut Hay.  
Grover C. Smart, Jr. and Barbara A. Wright, Tidewater Research Station, Holland, Virginia
14. 11:49 The Place of the Logarithmic Sprayer in Agricultural Research.  
H. M. LeBaron, Virginia Truck Experiment Station, Norfolk, Virginia
- 12:04 Lunch
15. 1:15 Observations on Body Weight and Surface Area of *Gallus domesticus*.  
A. T. Leighton, Jr., P. B. Siegel and H. S. Siegel, Poultry Department, VPI
16. 1:30 Problems in Standardization of an Empirical Procedure for Total Nitrogen Against the Official Kjeldahl Procedure.  
N. R. Thompson and W. K. Stone, Virginia Agricultural Experiment Station, VPI
17. 1:45 Observations on Excystation of Poultry Coccidia.  
Marion M. Farr and David J. Doran, Beltsville Parasitological Laboratory, USDA, Beltsville, Maryland
18. 2:00 Conception Rate in Beef Cows as Affected by Inbreeding of Fetus, and by Age and Inbreeding of Cow.  
K. P. Bovard and B. M. Priode, Beef Cattle Research Station, Front Royal, Virginia
19. 2:15 General Review of Relationships Between Pastures and Parasitism in Cattle.  
Halsey H. Vegors, Beltsville Parasitological Laboratory, USDA, Beltsville, Maryland
20. 2:30 The Quantitative Inheritance of 8-Week Breast Angle in *Gallus domesticus*.  
P. B. Siegel, Poultry Department, VPI

21. 2:45 *Ascaridia columbae* Larvae as the Cause of Severe Tissue Reaction in Liver of Pigeons.  
Everett E. Wehr, Beltsville Parasitological Laboratory, USDA, Beltsville, Maryland.
- 3:00 Recess
22. 3:10 Excystation of Sporozoites and Locomotion of the Motile Stages of *Eimeria acervulina* and *E. tenella*.  
David J. Doran, Beltsville Parasitological Laboratory, USDA, Beltsville, Maryland; T. L. Jahn and R. Rinaldi, Department of Zoology, University of California, Los Angeles, California
23. 3:25 Light Management for Commercial Layers.  
H. S. Siegel and W. L. Beane, Poultry Department, VPI
24. 3:40 Nutritive Value of Kelp Meal for the Growing Chick.  
E. L. Wisman and C. E. Howes, Poultry Department, VPI
25. 3:55 Appearance and Distribution of Blood Vessels in Fetal and Post-Natal Skins of Certain Sheep and Goats.  
Lubow A. Margolena, Animal Husbandry Research Division, USDA, Beltsville, Maryland
- 4:10 Business Meeting

## Section Of Astronomy, Mathematics And Physics

FRIDAY, MAY 11—8:55 A.M.

AZALEA ROOM

- 8:55 Announcements and Remarks by the Chairman.
1. 9:00 Activation Analysis of Fishbone Sample.  
Edward Bird, University of Florida and Robert R. Slocum, Norfolk College of William and Mary
2. 9:15 Radiometric Measurements of the Moon at 3.15 cm Wavelength.  
C. M. Bowden, University of Richmond and C. H. Mayer, U.S. Naval Research Laboratory
3. 9:30 Energy Levels in  $Al^{25}$  Below 7 Mev.  
W. T. Joyner, Hampden-Sydney College



4. 9:45 Time Resolution of Vernier Chronotron.  
J. E. Henderson, Hampden-Sydney College
5. 10:00 A Liquid Helium Scintillator for Measurement of Neutron Polarization.  
S. V. Topp and F. L. Hereford, University of Virginia
6. 10:15 Polarization of Neutrons from the  $\text{Li}^7(\text{d}, \text{n}) \text{Be}^8$  Reaction.  
F. L. Hereford and S. V. Topp, University of Virginia
7. 10:30 Solid Helium at High Pressure.  
J. W. Stewart, University of Virginia
8. 10:45 Electronic Properties of Tellurium at High Pressure and Low Temperature.  
R. E. Stajdohat and J. N. Boyd, University of Virginia
9. 11:00 Angular Correlation of Neutrons and Gamma Rays from the  $\text{B}^{11}(\text{d}, \text{n}) \text{C}^{12}$  Reaction.  
W. F. Huang and R. C. Ritter, University of Virginia
10. 11:15 Coulomb Excitation of Medium-Light Odd-A Nuclei.  
R. C. Ritter, University of Virginia
11. 11:30 Formation Conditions and Structure of Thin Epitaxial Ge Films.  
B. W. Sloope and C. O. Tiller, Virginia Institute for Scientific Research
12. 11:45 Space Velocities of Mira Variables.  
V. Osvalds, University of Virginia and A. Marguerita Risley, Randolph-Macon Women's College
- 12:05 Luncheon Recess
- 1:30 Business Meeting
13. 1:45 Equilibrium Ultracentrifugation.  
H. G. Kim, American Machine and Foundry Fellow and F. N. Weber, Jr., University of Virginia
14. 2:00 The Measurement of Partial Specific Volumes with the Magnetic Balance.  
J. W. Beams and A. M. Clarke, University of Virginia
15. 2:15 Possible Kerr Effect Produced by Lasers.  
J. W. Beams, University of Virginia
16. 2:30 Use of Fast Coincidence Techniques to Measure Dynamic Magnetic Fields.  
W. A. Walker and W. D. Whitehead, University of Virginia

17. 2:45 The Shape of Photonuclear Giant Resonances in La and Pr.  
L. B. Rice, L. N. Bolen and W. D. Whitehead, University  
of Virginia
18. 3:00 Use of Solid State Detectors in Photonuclear Reactions.  
W. R. Johnson and W. D. Whitehead, University of Virginia
19. 3:15 Exact Solution for a Least Square Sine Curve.  
C. M. Bowden, University of Richmond
20. 3:30 Panel and Discussion. Improvement of Physics Teaching.  
Moderator: Prof. F. L. Brown, University of Virginia  
Panel: Prof. T. E. Gilmer, Hampden-Sydney College  
Prof. S. M. Heflin, Virginia Military Institute  
Prof. D. D. Montgomery, Hollins College  
Prof. B. V. English, Randolph-Macon College

SATURDAY, MAY 12-9:00 A.M.

ROOM 800-801

21. 9:00 Effective Multiplication Constant of the VMI Subcritical  
Assembly.  
W. D. Harris, G. C. Ridgely and C. R. Thomas, Virginia  
Military Institute
22. 9:20 Electron Microscope Studies of Electrodeposition.  
K. R. Lawless and Lucille B. Garmon, University of Virginia
23. 9:40 A Solid State Neutron Spectrometer.  
G. T. Fairburn, W. B. Carpenter, A. K. Furr, Virginia Poly-  
technic Institute
24. 10:00 Gamma-Gamma Directional Correlation in  $\text{Cs}^{133}$ .  
J. K. Sun and C. D. Bond, Virginia Polytechnic Institute
25. 10:20 Pulsed Neutron Measurements in Water and Ice.  
J. A. McClure and A. Robeson, Virginia Polytechnic Institute
26. 10:40 Resonance Escape Probability in Thorium Nitrate Solutions.  
L. S. Anthony and A. Robeson, Virginia Polytechnic Institute
27. 11:00 Post-deadline papers.

## Section Of Bacteriology

FRIDAY, MAY 11—11:00 A.M.

Room 700

- 11:00 Business Meeting.
- 2:00 Scientific Session.
1. 2:00 The Demonstration of Lysozyme and Acid Phosphatase in the Subcellular Particles of Alveolar Macrophages.  
Eva S. Leake and William Hunt, Jr., University of Virginia School of Medicine.
  2. 2:20 The Identity of *Lactobacillus bulgaricus*.  
Judith H. Kahn and P. Arne Hansen, University of Maryland, College Park, Maryland.
  3. 2:40 The Effect of Selected Species of Bacteria on *Entamoeba histolytica*.  
E. Clifford Nelson and Muriel M. Jones, Medical College of Virginia.
  4. 3:00 Pathway of Ascorbic Acid Fermentation in *Aerobacter aerogenes*.  
Wesley A. Volk, University of Virginia School of Medicine.
  5. 3:20 Studies on Herpes Nutrition in Cell Culture.  
R. W. Tankersley, Medical College of Virginia.
  6. 3:40 Fluorescent Insulin.  
Gerald Goldstein, University of Virginia School of Medicine.
  7. 4:00 A Five Year Evaluation of the Resistance of *Mycobacterium tuberculosis* in Treated Patients.  
M. J. Allison and Miles E. Hench, Medical College of Virginia.
  8. 4:20 Human Listeria Infections in Virginia.  
H. J. Welshimer, Medical College of Virginia.

## Section Of Biology

FRIDAY, MAY 11—8:45 A.M.

CAMELLIA ROOM

1. 8:45 Nomenclature of *Zephyranthes aurea* Watson and *Z. longifolia* Hemsley.  
R. O. Flagg and W. S. Flory, Jr., The Blandy Experimental Farm, University of Virginia.
2. 9:00 Taxonomic Position of *Cooperia* Herbert.  
R. O. Flagg and W. S. Flory, Jr., The Blandy Experimental Farm, University of Virginia.
3. 9:15 The Effect of Photoperiod on Certain Ferns.  
Paul M Patterson and A. Sewell Freeman, Hollins College.
4. 9:30 Needed: A New Concept in Ecological Conservation Education in Urban Areas.  
Joseph J. Shomon, National Audubon Society.
5. 9:45 Some Vegetational Studies of Natural and Disturbed Piedmont Forests.  
Dorothy L. Crandall, Randolph-Macon Woman's College.
6. 9:55 Small Mammal Populations of Natural and Disturbed Piedmont Forests.  
James L. Chamberlain, Randolph-Macon Woman's College.
7. 10:05 Determination of Oxygen in Water Using a 10 ml. Syringe.  
James D. Burke, University of Richmond.
8. 10:20 Nutritional Requirements for Ascospore Germination: *Podospora anserina* Niessl.  
James E. Perham and A. Gib DeBusk, Randolph-Macon Woman's College and Florida State University.
9. 10:30 Respiratory Response of Germinating Ascospores: *Podospora anserina* Niessl.  
Elizabeth Davis and Eleanor Bowen, Randolph-Macon Woman's College.
- 10:40 Section Business Meeting.
10. 11:15 Invitation Paper. The Dynamics of Predator Populations and the Effects on Rabies Control.  
Nelson Swink, District Agent, P.A.R.C. Bureau of Sport Fisheries and Wildlife.



## LUNCH.

11. 1:45 A Spectrophotometric Procedure for Determination of Oxy-hemoglobin Affinity Curves.  
Jack D. Burke and W. Allan Powell, University of Richmond.
12. 2:00 A Photographic Instrument to Determine Cellular Growth Rates in the Roots of Small-Seeded Grasses.  
Robert T. Brumfield, Longwood College.
13. 2:15 A Simple Technique for Removing Fish Blood.  
James D. Burke, University of Richmond.
14. 2:25 Calcium Metabolism and the Molting Cycle of the Crayfish *Combarus longulus longulus* Girard.  
Rose Mary Johnson, Norfolk College of William and Mary.
15. 2:35 The Influence of Formalin and Bodily Restraint on the Blood Pressure and Body Temperature of Young Chickens.  
K. W. Washburn and H. S. Siegel, Virginia Polytechnic Institute.
16. 2:50 Responses of the Newt Pituitary Gland to Thyroidal Depression.  
J. N. Dent, University of Virginia.
17. 3:05 Observations of Epidermal Differentiation in Regenerating *Dugesia dorotocephala*.  
Margaret Anderson Gordon, University of Virginia and Madison College.
18. 3:20 Preliminary Observations on the Behavior of Certain Species of Argasid Ticks with Respect to Relative Humidity.  
Daniel E. Sonenshine, Norfolk College of William and Mary.
19. 3:35 Studies on the Genitalia of Certain Spiders of the Genus *Dolomedes* (Pisauridae, Araneae).  
James E. Carico, Virginia Polytechnic Institute.
20. 3:50 The Biology of the Virginia Pine Sawfly, *Neodiprion pratti pratti* (Dyar).  
Marvin L. Bobb, Virginia Agricultural Experiment Station, Charlottesville.
21. 4:05 Geographic Variation in the Crawfish *Orconectes (Faxonella) clypeatus* (Hay).  
J. F. Fitzpatrick, Jr., University of Virginia.
22. 4:17 Geographic Variation in the Chorus Frog, *Pseudacris triseriata*

Wied. 1839, in the Middle Atlantic States.  
Duvall A. Jones, Madison College.

23. 4:32 Reptiles and Amphibians of the Dismal Swamp of Virginia and Adjacent Coastal Plain of North Carolina.  
Roger H. de Rageot, Natural History Division of Norfolk Museum.

At the conclusion of this paper interested persons are invited to visit the Natural History Gallery of the Norfolk Museum.

SATURDAY, MAY 12—9:00 A.M.

WEST BALLROOM

24. 9:00 Marl Deposition by the Algae *Oocarbium stratum* and *Chara vulgaris* in Montgomery County, Virginia.  
Harold L. Mathews, Virginia Agricultural Experiment Station, V. P. I.
25. 9:15 The Buccal Infraciliature as the Distinguishing Generic Characteristic in the Ciliate Order Hymenostomatida.  
Jesse C. Thompson, Jr., Hollins College.
26. 9:30 A Preliminary Ecological Study of the Bryozoan, *Lophopodella carteri* (Hyatt) in Virginia.  
Wilton R. Tenney and William S. Woolcott, University of Richmond.
27. 9:45 Infectious Diseases Damages Mid-Atlantic Oyster Populations.  
Jay D. Andrews, Institute of Marine Science, Gloucester Point.
28. 10:00 Observations on Nucleolar Extrusions in Megasporeocytes of Selected Members of the Family Liliaceae.  
Elizabeth M. Weiland, Randolph-Macon Woman's College and University of Virginia.
29. 10:10 A Monograph of the Genus *Aphpanomyces*.  
William W. Scott, Virginia Polytechnic Institute.
30. 10:25 A Preliminary Report of the Aquatic Fungi Associated with Diseased Fish and Fish-eggs.  
W. W. Scott, Aaron H. O'Bier, and James Powell, Virginia Polytechnic Institute and Stetson University.
31. 10:40 The Life-cycle of a Keratinophilic fungus, *Leptolegniella keratinophilum* Huneycutt.  
Roland Seymour and W. W. Scott, Virginia Polytechnic Institute.

32. 10:55 Some New and Unusual Aquatic Fungi from Virginia.  
W. W. Scott and Charles Warren, Virginia Polytechnic Institute.
33. 11:10 The Genus *Calostoma* Zeller in Virginia.  
Mary Virginia Charlton, Virginia Polytechnic Institute.
34. 11:25 A New Genus of the Family Branchiobdellidae.  
Perry C. Holt, Virginia Polytechnic Institute.
35. 11:40 Some Ecological Studies of the Family Branchiobdellidae.  
George Gordon Brown, University of Virginia.

## Section Of Chemistry

FRIDAY, MAY 11—9:00 A.M.

WEST BALLROOM

- 9:00 Announcements. Introductory Remarks.
1. 9:15 Models of Molecular Orbitals.  
Edward B. Eadie, Jr., and John H. Wise, Department of Chemistry, Washington and Lee University.
2. 9:30 A New Second-Level Course in Chemistry: Progress Report.  
Beatrice E. Gushee, Department of Chemistry, Hollins College.
3. 9:45 Spectrophotometric Studies on Hydroxamic Acids and their Reactivity with Metallic ions: Determination of Vanadium (V) with 2-Naphthylhydroxamic Acid.  
Virginia C. Chamblin and John H. Yoe, Department of Chemistry, University of Virginia.
4. 10:00 Taste-Structure Correlation with  $\alpha$ -D-Mannose and  $\beta$ -D-Mannose.  
Ralph G. Steinhardt, Jr., Allen D. Calvin, and Elizabeth Anne Dodd, Department of Chemistry, Hollins College.
5. 10:15 Molecular Addition Compounds Between Iodine Chlorides and Various Electron Donors.  
Robert D. Whitaker, George B. Fozzard, John R. Ambrose, and C. W. Hickam, Department of Chemistry, Washington and Lee University.
- 10:30 RECESS.
6. 10:45 Preparation of High-Purity Single-Crystal Boron.

Claude P. Talley and Gerald R. Taylor, Jr., Texaco Experiment Incorporated.

7. 11:00 Electron Microscope Investigation of a Catalytic Reaction on Copper Single Crystal Thin Films.  
T. F. Swank, K. R. Lawless, and A. T. Gwathmey, Cobb Chemical Laboratory, University of Virginia.
8. 11:15 The Initial Stages of Oxidation of a Copper Single Crystal.  
Don F. Mitchell, K. R. Lawless, and A. T. Gwathmey, Cobb Chemical Laboratory, University of Virginia.
9. 11:30 The Catastrophic Oxidation of Aluminum in Contact with Mercuric Halides.  
D. A. Jackson, Jr., and H. Leidheiser, Jr., Virginia Institute for Scientific Research.
- 11:45 BUSINESS MEETING.
10. 1:00 The Thermodynamics of The Molten Salt System  $\text{KNO}_3\text{--AgNO}_3\text{--K}_2\text{CrO}_4$  from Electromotive Force Measurements.  
Robert M. Auburn and William J. Watt, Department of Chemistry, Washington and Lee University.
11. 1:15 Measurement of Paramagnetic Susceptibility.  
Kerford A. Marchant, Jr., E. F. Turner, Jr., and John H. Wise, Department of Chemistry, Washington and Lee University.
12. 1:30 A Theoretical Study of Reaction Efficiency.  
Frederick M. Hornyak, Department of Chemistry, Virginia Polytechnic Institute.
13. 1:45 Studies of Antioxidants and Inhibitor Mechanisms at Elevated Temperatures.  
James W. Cole, Jr., Oscar R. Rodig, Robert K. Schlatter and Ertle Thompson, Cobb Chemical Laboratory, University of Virginia.
14. 2:00 Unsaturated Cyclic Sulfoxides.  
Robert C. Krug and Donald E. Boswell, Department of Chemistry, Virginia Polytechnic Institute.
15. 2:15 N-Alkoxy Substituted Dithiocarbamates.  
R. T. Major and J. A. Hardy, Cobb Chemical Laboratory, University of Virginia.
16. 2:30  $\alpha$ -Diketones from  $\alpha, \alpha'$ -Dibromoketones.  
George H. Denny, Jr., and Robert D. Wysong, Department of Chemistry, Virginia Polytechnic Institute.



2:45 RECESS.

17. 3:00 Oxidative Rearrangements of Tetraphenylpyrrole.  
D. W. Boykin and R. E. Lutz, Cobb Chemical Laboratory,  
University of Virginia.
18. 3:15 Base-Induced Hydrolytic Rearrangement of trans-gamma-Bromodipnone to 1,2-Dibenzoylthane.  
Robert E. Lutz, Landrey T. Slade and Phillip A. Zoretic, Cobb  
Chemical Laboratory, University of Virginia.
19. 3:30 A Novel Synthesis Using Grignard Reagents.  
Frank A. Vingiello, Sih-gwan Quo and John Sheridan, Depart-  
ment of Chemistry, Virginia Polytechnic Institute.
20. 3:45 The Synthesis of Some New Thiophene Containing Poly-  
nuclear Compounds.  
Frank A. Vingiello, Sih-gwan Quo and Perry Polss, Depart-  
ment of Chemistry, Virginia Polytechnic Institute.
21. 3:55 A Study of the Synthesis and Aromatic Cyclodehydration of  
2-(2-Naphthylmethyl)-2'-chloro-5'-methylbenzophenone.  
Frank A. Vingiello and Leo Ojakaar, Department of Chemis-  
try, Virginia Polytechnic Institute.
22. 4:05 The Synthesis of 7-Phenyldibenz (a, h) anthracene.  
Frank A. Vingiello and Paul D. Henson, Department of Chem-  
istry, Virginia Polytechnic Institute.
23. 4:15 The Synthesis of N-3-Carboxyhydrazonopropanoyl)-4-  
aminobenzoic Acid and Its Use as a Carbonyl Reagent.  
James K. Shillington, Henry C. Hawthorne, Jr., and Bruce T.  
Houghton, Department of Chemistry, Washington and Lee  
University.
24. 4:30 Characterization and Determination of Aldehydes by the Ultra-  
violet Spectral Changes Resulting from Acetal Formation.  
E. P. Crowell, W. A. Powell, and C. J. Varsel, Department  
of Chemistry, University of Richmond, and Philip Morris Re-  
search Center.
25. 4:45 Mass Spectra Correlations and Appearance Potentials of the  
Major Tobacco Alkaloids.  
W. F. Kuhn, C. J. Varsel, and W. A. Powell, Department  
of Chemistry, University of Richmond and Philip Morris Re-  
search Center.

## Section Of Engineering

FRIDAY, MAY 11—9:00 A.M.

ROOMS 601 and 800

Meeting I—James B. Eades, Jr., Meeting Chairman, Department of  
Aerospace Engineering, Virginia Polytechnic Institute  
ROOM 601

1. 9:00 A Comparison of Published Data with Theoretical Results for the Compressible Turbulent Skin Friction.  
John B. Peterson, Jr., Langley Research Center, National Aeronautics and Space Agency.
2. 9:30 On the Prediction of Aerodynamic Load Distributions on Finite Wings by the Subsonic Kernel Function Method. 1. Unsteady Case—Flutter Characteristics.  
Gerald D. Walberg, Langley Research Center, National Aeronautics and Space Agency.
3. 10:00 On the Prediction of Aerodynamic Load Distributions on Finite Wings by the Subsonic Kernel Function Method. 2. Steady Case—Wing Loads.  
John M. Mugler, Jr., Langley Research Center, National Aeronautics and Space Agency.
4. 10:30 An Investigation of the Fluctuating Forces Acting on a Stationary Cylinder in a Subsonic Stream, and the Associated Sound Field.  
Roger T. Keefe, Aerospace Engineering Department, Virginia Polytechnic Institute.
5. 11:00 Effect of Aerodynamics on the Perturbations of a Near Earth Orbit and the Ballistic Reentry Trajectory.  
Alton P. Mayo, Langley Research Center, National Aeronautics and Space Agency.
6. 11:30 A Numerical Solution to the Problem of Incompressible Flow in the Inlet Length of a Straight Channel.  
R. A. Chubboy, Aerospace Engineering Department, Virginia Polytechnic Institute.
7. 1:00 The Influence of Precession of Earth Rendezvous Orbits on Lunar Mission Requirements.  
William R. Wells, Langley Research Center, National Aeronautics and Space Agency.

8. 1:30 Theory and Experiment for a Rotational Plasma Accelerator.  
William Grossman, Jr., Langley Research Center, National Aeronautics and Space Agency.
9. 2:00 Compensation of Open Loop Unstable Feedback Systems to Achieve Unconditioned Stability.  
Orville R. Harris, Electrical Engineering Department, University of Virginia, Charlottesville.
10. 2:30 Spin Dynamics of Manned Space Stations.  
Peter R. Kurzhals, Langley Research Center, National Aeronautics and Space Agency.
11. 3:00 A Time Dependent Solution to the Launch Vehicle Response Problem.  
Dennis F. Collins, Jr., Langley Research Center, National Aeronautics and Space Agency.
12. 3:30 Radio Star Scintillations.  
E. C. Stevenson, Electrical Engineering Department, and Jas. P. Hollinger, formerly Physics Department, University of Virginia, Charlottesville.
13. 4:00 Determination of Newtonian Force Coefficients for a Typical Reentry Configuration.  
E. Brian Pritchard, Langley Research Center, National Aeronautics and Space Agency.
14. 4:30 Range Control During Initial Phases of Supercircular Reentries.  
Donald L. Baradell, Langley Research Center, National Aeronautics and Space Agency.

Meeting II—John F. Eckel, Meeting Co-Chairman, Department of Metallurgical Engineering, Virginia Polytechnic Institute, Blacksburg  
ROOM 800

15. 9:00 What Engineers and Scientists Should Know About Patents.  
Auzville Jackson, Jr., Assistant General Solicitor, Patents, Robertshaw-Fulton Controls Company, Richmond.
16. 9:25 A Study of the Effects of Dynamic Loads Upon the Engineering Characteristics of Soils.  
H. G. Larew, Civil Engineering Department, University of Virginia, Charlottesville.
17. 9:50 Significance of Layer Deflection Measurements in Flexible-Type Pavements.  
Richard D. Walker, Civil Engineering Department, Virginia Polytechnic Institute.

18. 10:15 Adaptation of Agricultural Soil Maps for Engineering Use.  
John H. Hunter, and Robert D. Krebs, Civil Engineering Department, Virginia Polytechnic Institute.
19. 10:40 The Effects of Neutron-Gamma Irradiation Upon the Physico-Chemical Properties of Soils.  
M. T. Tumay, and H. G. Larew, Civil Engineering Department, and J. Lawrence Neem, Nuclear Engineering Department, University of Virginia, Charlottesville.
20. 11:05 Rating Soils for Residential Sewage Disposal.  
Robert D. Krebs, and John H. Hunter, Civil Engineering Department, Virginia Polytechnic Institute.
21. 11:30 Determination of the Total Neutron Flux Near a Reactor Corner.  
J. D. Spencer, and T. G. Williamson, Nuclear Engineering Department, University of Virginia, Charlottesville.  
Lunch.
22. 1:30 Analysis of the Operation of a Static Switched D. C. Voltage Regulator Employing a Power Semiconductor as the Switching Element.  
Ricardo Berner, and Eugene E. McVey, Electrical Engineering Department, University of Virginia, Charlottesville.
23. 1:55 Nitrogen Diffusion Constants in Austenitic Stainless Steel as Determined by Internal Friction Measurements.  
C. R. Manning, and J. F. Eckel, Metallurgical Engineering Department, Virginia Polytechnic Institute.
24. 2:20 Dynamic Response of a Pulsed Liquid Extraction Column.  
John J. Watjen, and Robert N. Hubbard, Chemical Engineering Department, University of Virginia, Charlottesville.
25. 2:45  $\text{Cr}_3\text{O}$  Structure in the Ternary Systems Cr-Si-Sn and V-Si-Sn.  
P. B. Lassiter and John F. Eckel, Metallurgical Engineering Department, Virginia Polytechnic Institute.
26. 3:10 Viscosity Measurement Using a Bourdon Tube.  
Robert M. Hubbard, Chemical Engineering Department, University of Virginia, Charlottesville.
27. 3:35 Preliminary Investigation into the Thermodynamics of the Nitriding Reaction for Austenitic Stainless Steel.  
E. L. Williams, Jr., Metallurgical Engineering Department, Virginia Polytechnic Institute.
28. 4:00 Solubility, Vapor Pressure and Liquid Density in the  $\text{CO}_2$ -Methylene Chloride System.



Frederick H. VonderHeiden, and John W. Eldridge, Chemical Engineering Department, University of Virginia, Charlottesville.

29. 4:25 Static Relaxation in Austenitic Stainless Steels.  
W. H. Hernstein, and J. F. Eckel, Metallurgical Engineering Department, Virginia Polytechnic Institute.

## Section Of Geology

FRIDAY, MAY 11—9:00 A.M.

ROBERT E. LEE ROOM

9:00 Announcements.

1. 9:20 The formation of calcareous tufa deposits in Montgomery County, Virginia.  
H. L. Mathews, Virginia Agricultural Experiment Station Chesterfield, Virginia.
2. 9:40 Geology and the Civil War in Virginia.  
R. L. Ellison, University of Virginia.
3. 10:00 Geology of the Williamsville quadrangle, Virginia.  
K. F. Bick, College of William and Mary.
4. 10:20 A geophysical investigation of sulfide deposits near New Canton, Virginia.  
R. C. Barnes, University of Virginia.
5. 10:40 Fractured rocks and the occurrence of ground water, Shenandoah Valley, Virginia.  
F. W. Trainer and R. L. Ellison, University of Virginia.
6. 11:00 Structural analysis in metamorphic rocks.  
E. W. Spencer, Washington and Lee University.
- 11:30 Business meeting.
- 12:00 Recess.
7. 2:00 An evaluation of biogeochemical prospecting, Shenandoah Valley, Virginia.  
E. H. McGavock, University of Virginia.
8. 2:20 A preliminary report on the mineralogy of the Alberene soapstone deposit, Albemarle County, Virginia.  
H. N. Giles, 105 Observatory Avenue, Charlottesville.

9. 2:40 Clay Mineralogy of Some Piedmont Soils as Related to their Source Rock Petrography.  
William M. Flock, VPI.
10. 3:00 Narrows Fault Zone, Narrows, Virginia.  
Edwin K. Via, VPI.
11. 3:20 The Blue Ridge Fault Near Front Royal.  
Fitzhugh T. Lee, VPI.
12. 3:40 Magnetic susceptibilities and magnetic anomalies in the Radford Area.  
Samuel T. Harding, VPI.
13. 4:00 Petrography of the Arvonnia Slate.  
Robert G. McDowell, VPI.
14. 4:20 Ground Water Geology Along the West Flank of the Blue Ridge in Rockbridge, Augusta and Rockingham Counties.  
R. B. Leonard, VPI.

SATURDAY, MAY 12

Field Trip.

## Section of Medical Science

FRIDAY, MAY 11—9:00 A.M.

MADISON ROOM

1. 9:00 Effect of Hydrocortisone Feeding on Serum Cholesterol and Triglycerides in Rabbits.  
J. C. Forbes and O. M. Petterson, Medical College of Virginia.
2. 9:20 Influence of Cortisone and Hydrocortisone on Absorption of Cholesterol-C<sup>14</sup>.  
E. S. Higgins and J. C. Forbes, Medical College of Virginia.
3. 9:40 Pathway of Glucose Metabolism in Brain and Influence of Ethanol on *Gamma*-Aminobutyric Acid Content.  
E. S. Higgins, Medical College of Virginia.
4. 10:00 Active Sodium Transport Across the Skin in Intact Frogs.  
Addison D. Campbell, Carey Stronach and Ernst G. Huf, Medical College of Virginia.
5. 10:20 Effects of Redox Systems on Active Ion Transport in Isolated Frog Skin.

Ernst G. Huf, Leah L. Eubank, Addison D. Campbell and Barbara B. Taylor, Medical College of Virginia.

6. 10:40 Use of High Intensity Light on Experimental Intraocular Tumors.  
Guy Chan and Walter J. Geeraets, Medical College of Virginia.
7. 11:00 Studies of Proteins of Bone.  
H. G. White, Jr., Herman M. Nachman and E. R. Berry, Medical College of Virginia.
8. 1:30 Specificity of Electric Organ Cholinesterase.  
Mary-Elizabeth Mounter, Rita M. Cheatham and L. A. Mounter, Medical College of Virginia.
9. 1:50 Effect of X-rays on Enzymes.  
L. A. Mounter, Medical College of Virginia.
10. 2:10 Effect of 17-Ethyl-19-Nortestosterone on Blood Glucose in the Alloxan Diabetic Rat.  
J. A. Thomas, University of Virginia School of Medicine.
11. 2:30 The Effects of Iodinated Salicylates on Pulse Rates of Rats.  
C. L. Gemmill and K. M. Browning, University of Virginia School of Medicine.
12. 2:50 Fluid Therapy and Normothermia in Hemorrhagic Shock in the Cat.  
Eugene D. Brand, University of Virginia School of Medicine.
13. 3:10 Effect of Ouabain and Insulin on Potassium Fluxes in Frog Muscle.  
D. R. H. Gourley, University of Virginia School of Medicine.
14. 3:30 A Broad Range Micro Spectrodensitometer for Agar Electrophoresis.  
R. C. Williams, R. S. Ruffin and E. R. Berry, Medical College of Virginia.

## Section Of Psychology

FRIDAY, MAY 11—8:30 A.M.

DOGWOOD ROOM

8:30 Announcements, Richard H. Henneman, *Chairman*.

1. 8:45 Perseveration of Traces in the Tachistoscopic Recognition of Words.

John J. Baldino, Jr., The College of William and Mary.

2. 9:00 Tachistoscopic Recognition of Words and Their Mirror Images.  
Mary Ellen Finkel, The College of William and Mary.
3. 9:15 Perception of Number in Peripheral Vision.  
Charles C. Hodge, The College of William and Mary.
4. 9:30 A Study of Magnitude of Errors on the Pursuit Rotor.  
Robert S. Klein and George W. Kent, Bridgewater College.
5. 9:45 Psychomotor Factors in Piloting Manned Spacecraft.  
Gerald W. Bracey, The College of William and Mary.
6. 10:00 The Effect of Various Event Run-Lengths on Human Binary Prediction.  
Peter L. Derks and Lois Gurnee Blanchard, The College of William and Mary.
7. 10:15 The Effects of Various Schedules of Reinforcement on Two-Choice Behavior in Human Subjects.  
George J. Skrzypek, The College of William and Mary.
8. 10:30 The Effect of Pronounceability and Mode of Presentation on Acquisition of CVC Trigrams.  
John M. Williams, The College of William and Mary.
- 10:45 Recess.
9. 11:00 Symposium on "Consumer-Producer Expectations in Psychology."  
Neil W. Coppinger, *Chairman*, Edwin S. Zolik, Cyril R. Mill, John J. McMillan, Louis D. Cohen, and Robert S. Waldrop.
- 12:30 Lunch.

PETER L. DERKS, *Chairman*

10. 1:30 The Effect of Frequency of Presentation upon Responses to Stimuli of Varying Degrees of Ambiguity.  
James H. Brown, University of Virginia.
11. 1:45 Transfer of Classification and Identification Experience to Recognition of Random Shapes.  
Russell B. Johnson, University of Virginia.
12. 2:00 The Effects of Training in Communication and Role Perception on Communicative Abilities in Children.  
Charles Luther Fry, Jr., University of Virginia.



13. 2:15 Serial Rote Learning as a Function of Overt Errors and Rate of Presentation.  
John P. Harcourt and Milford F. Schwartz, Washington and Lee University.
14. 2:30 Constant vs. Varied Serial Order in Paired-Associate Learning and Retention.  
Douglas Birtcher, University of Virginia.
15. 2:45 Method of Pretraining and Knowledge of Results in Paired-Associate Learning under Simultaneous Repetition and Non-repetition Conditions.  
H. Ray Brackett, University of Virginia.
16. 3:00 Time-out from Positive Reinforcement.  
Donald M. Thompson, University of Virginia.
- 3:15 Recess.
17. 3:30 Audience-participation discussion on "The Concept of Drive".  
Stanley B. Williams, *Chairman*, Robert A. Johnson, and L. Starling Reid.
- 4:30 Business Meeting: Psychology Section of the Virginia Academy of Science.
- 5:30 Social Hour and Dinner: Virginia Psychological Association.

SATURDAY, MAY 12—8:30 A.M.

DOGWOOD AND ROBERT E. LEE ROOM

SESSION A—ROBERT E. LEE ROOM

Leonard E. Jarrard, *Chairman*

18. 8:30 Effects of D-Lysergic Acid Diethylamide on Food Consumption in the Rat.  
Donald A. Stubbs, Washington and Lee University.
19. 8:45 Operant Conditioning and Food Consumption as Indicators of the Effects of X-irradiation on Rats.  
Walfred B. Thulin, Washington and Lee University.
20. 9:00 The Effects of Caffeine and Sodium Seconal on Operant Behavior in the Rat.  
Clarence M. Whitehead, Jr., Washington and Lee University.
21. 9:15 Modifications in the Rat's Diurnal Behavior as a Function of Quinine Concentration in a Liquid Diet.  
John W. Wright, University of Virginia.

22. 9:30 The Effect of Varied and Constant Drinking Location on Activity and Exploration in the Rat.  
George J. Igel and James H. Woods, University of Virginia.
23. 9:45 The Effect of Field Illumination Upon Exploratory Behavior in the Rat.  
W. C. Westman, The College of William and Mary.

## SESSION B—DOGWOOD ROOM

Stanley Spiegel, *Chairman*

24. 8:30 The Sensitization-Represison Dimension as Related to Deviant Responses on Content and Contentless Tasks.  
A. W. Lucky, University of Richmond.
25. 8:45 Female Masturbation and Marital Happiness Prediction.  
William R. Reevey, Northern Virginia Mental Health Project.
26. 9:00 The Lack of Agreement Between M-F-D Test Scores and Psychiatric Diagnoses.  
Bessie S. Smith, Lower Peninsula Mental Hygiene Clinic.
27. 9:15 The Rorschach and the MMPI: A Concurrent Validity Study.  
Henry B. Adams, VA Hospital, Richmond, G. David Cooper, Petersburg Training School, and Richard N. Carrera, Emory University.
28. 9:30 A Content Analysis Study of Group Therapy Sessions.  
William R. Reevey, Edwin S. Zolik, and Elmer F. Lowry, Jr., Northern Virginia Mental Health Project.
- 9:45 Recess.
29. 10:00 Symposium on "Implications for Psychology of the Joint Commission Report on Mental Health."  
Harold M. Hildreth, Chairman, with discussants on Training, Practice, Schools, Research, and Interdisciplinary Coordination.
- 11:30 Business Meeting: Virginia Psychological Association.

## Section Of Science Teachers

THURSDAY, MAY 10—2:00 P.M.

ROOM 800-801

1. 2:00 Functional vs. Classical Biology and the Placement of Biology in the High School Curriculum.  
John G. Barker, Head of Biology Department, Radford, College.
- 2:55 Intermission.
- 3:05 Business Session.
2. 3:20 History of the Section of Science Teachers.  
Miss Samuella Crim, Glassboro State College, Glassboro, N. J.

## Section Of Statistics

FRIDAY, MAY 11—9:30 A.M.

ROOM 701

- 9:30 Introduction by Chairman.
1. 9:40 A Statistical Analysis of a Crop Rotation Experiment.  
M. H. Kutner, Virginia Polytechnic Institute.
2. 10:00 On the Unwisdom of Treating the Worst.  
C. Eisenhart, and Mary C. Croarkin, National Bureau of Standards.
3. 10:40 Time Series and Spectral Analysis.  
G. A. Watterson, Virginia Polytechnic Institute.
4. 11:10 Some Statistical Applicaitons at the U. S. Naval Weapons Laboratory.  
Victor Chew, U. S. Naval Weapons Laboratory.
5. 11:30 Inference on a Genetic Model.  
J. J. Bartko, Virginia Polytechnic Institute.
6. 2:00 A Nonlinear Model for the Nutritional Evaluation of Protein Quality.  
R. J. Monroe, N. C. State College and Medical College of Virginia; M. A. Guzman, Institute for Nutrition of Central America and Panama.

7. 3:00 An Index to Determine Quantitative Immunization.  
I. A. De Armon Jr., F. Klein, R. E. Lincoln, B. G. Mahlandt,  
and A. L. Fernelius, U. S. Army Chemical Corps.
8. 3:40 Some Aspects of Life Tables.  
W. L. Johnson, Virginia Polytechnic Institute.
- 4:10 Business Meeting.

SATURDAY, MAY 12—9:00 A.M.

ROOM 701

9. 9:00 Representative Selection of Variables.  
R. A. Bales, Technical Operations, Inc.
10. 9:20 Various Components of Three-way Classifications with Unequal  
Class Number.  
P. S. Chu, Virginia Polytechnic Institute.
11. 9:40 Designs for Blocks of Size Two.  
H. A. David, Virginia Polytechnic Institute.
12. 10:10 Statistical Investigation of Teller Performance in Branch Bank-  
ing.  
S. P. Shao and T. J. Reed, Norfolk College of William and
13. 10:40 Estimation of the Strength of a Radioactive Source.  
Kimiko O. Bowman and H. A. David, Virginia Polytechnic  
Institute.
14. 11:10 A Rank Sum Test for Outliers.  
W. A. Thompson, Jr., and T. A. Willke, National Bureau of  
Standards.







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Contributions to the Journal should be addressed to Paul B. Siegel, Virginia Polytechnic Institute, Blacksburg, Virginia. If any preliminary notes have been published on the subject which is submitted a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8 1/2" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscript into subheadings must follow a consistent plan. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashedline above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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# THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE  
VIRGINIA ACADEMY OF SCIENCE



SYMPOSIUM ON BASIC RESEARCH  
ON VIRGINIA'S NATURAL RESOURCES



VOL. 13, NEW SERIES

No. 3

JULY, 1962

## THE VIRGINIA JOURNAL OF SCIENCE

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# THE VIRGINIA JOURNAL OF SCIENCE

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VOL. 13, NEW SERIES

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## BASIC RESEARCH ON VIRGINIA'S NATURAL RESOURCES

Symposium Sponsored by  
The Virginia Institute for Scientific Research  
and  
The Virginia Academy of Science  
Norfolk, Virginia May 10, 1962

"Basic Research on Virginia's Natural Resources" was the subject of a symposium, jointly sponsored by the Virginia Institute for Scientific Research and the Virginia Academy of Science, at the Fortieth Annual Academy Meeting in Norfolk, Virginia, May 10, 1962.

The idea for such a symposium was presented by Dr. Henry Leidheiser, Jr., Director of VISR, to the Academy Council in the spring of 1961. It was enthusiastically accepted and a four-man committee was appointed to select subjects and to invite outstanding nationally-known speakers. The committee consisted of Dr. Byron N. Cooper, professor of geology, Virginia Polytechnic Institute; Dr. Ladley Husted, professor of biology, University of Virginia; Dr. Leidheiser, and Dr. Russell J. Rowlett, Jr., Assistant Director of VISR.

The six subjects chosen by the committee represent, in their opinion, the six most important natural resources in Virginia. It is apparent that many natural resources were omitted — limestone, zinc, iron ore, manganese, salt and wildlife, to mention only a few. Their omission was the result of time considerations only.

The committee studied carefully suggestions for possible speakers, and consulted frequently with well-known scientists in industry, the universities, and federal government laboratories. Each of the speakers selected is a recognized authority in his field. In introducing the symposium Dr.

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Leidheiser stated that "the Institute and the Academy are highly honored and complimented that the invitations were accepted so willingly."

Each speaker was introduced by a member of the Virginia Academy. Dr. Thiessen was introduced by Dr. William P. Boyer, Vice President, Virginia-Carolina Chemical Corporation; Dr. Norman by Edwin Cox, Senior Partner, Cox and Gillespie; Dr. Hepting by George W. Dean, Virginia State Forester; Dr. Frye by Dr. Byron N. Cooper; Dr. McHugh by Dr. William J. Hargis, Director, Virginia Institute of Marine Science; and Dr. Little by H. Rupert Hanmer, Vice President, American Tobacco Company.

Extra copies of this July issue of the *Virginia Journal of Science* containing the complete symposium may be obtained for one dollar (\$1.00) from The Virginia Institute for Scientific Research, 2820 Grove Avenue, Richmond 21, Va.



## BASIC RESEARCH ON COAL

DR. GILBERT THIESSEN, *Administrative Assistant to the Vice President and Director of Research, Koppers Company, Inc., Pittsburgh, Pa.*

Probably the most basic research on coal is to find an answer to the question, "What is coal?"

Everyone knows coal is that earthy brown stuff dug out of open pits in Texas or Germany or Australia and burned under power plant boilers. But it is also the hard, shiny clean smokeless fuel mined extensively at one time in Northeastern Pennsylvania and in parts of Virginia and called hard coal. It is also the tough black material mined in Eastern Central Ohio, near Cannelton, and distilled to make coal oil which, in its time, destroyed the whale oil industry and which, in turn, was superseded by kerosene from petroleum. Also, it is the wide variety of bituminous coals with names such as Pocahontas, Pittsburgh, Illinois No. 6, etc. Coal is that new product of the research laboratory — a solid fuel that does not need to be kept in a tank.

Virginia has been, is, and will continue to be an important coal producing state. Though coal, in the U. S., was not found first in Virginia, it was mined and used first here. The use was industrial, providing heat in blacksmiths' forges. A curious comment about Virginia coal in 1720 says, "And as for coals, it is not likely they should ever be used there in anything, but Forges and great Towns, if ever they happen to have any; for, in their Country Plantations, the Wood grows at every Man's Door so fast, that after it has been cut down, it will in seven Years time, grow up again from seed to substantial Fire Wood." Virginia is sixth in coal production in the U. S., yielding 6.7% of the bituminous coal and lignite produced in the U. S. in 1960. Virginia has some of the geologically oldest coals in the U. S., and some of its best.

Before discussing coal research, let us consider coal itself. Coal appears in wide variety in nature, but all varieties have one thing in common — they are derived from accumulated vegetation which has partly decayed, then, while entombed in rock, has become dried, compressed, and gradually changed into coal. The nature of the starting vegetation and the conditions of decay determined the type. The position of a coal in the scheme of change from lignite to bituminous coal to anthracite defines its rank. Coals thus vary in type and rank. Those in Virginia are mainly the normal bright banded and the splint types and of bituminous rank.

What causes the change from partly decayed vegetation to coal? Time, temperature, pressure and nature of the chemical environment are prob-

sible, for very old low rank coals and young high rank coals occur in various parts of the world. Temperature is an important factor, even though it is believed that during the entire period of coalification it did not rise much above those we now can measure in coal beds. However, only a slight rise is enough since, generally in organic chemical reactions, a rise in temperature of  $10^{\circ}\text{C}$  ( $18^{\circ}\text{F}$ ) doubles the rate of reaction and the reactions took place over geological periods of time. Pressure also is needed, but just enough to cause compaction. Where mountain building or massive structural movements produced high pressures in formations containing coal beds, the increased temperatures were probably more responsible for the increased rank of the coal than were the higher pressures. Where relatively high temperatures developed due to intrusions of hot igneous rocks, a marked increase in degree of coalification of coal beds near them occurred, increasing in degree with nearness to the intrusion. Under these conditions, reactions leading to heat alteration of the organic material went on faster than the less violent dehydration, decarboxylation, and dehydrogenation, which are the processes of coalification.

Virginia, in its Richmond coal basin in Chesterfield, Powhatan, Goochland, and Henrico counties exhibits an outstanding example of the temperature effect of igneous intrusion in the neighborhood of a coal bed. Here coals in a single bed progress in rank from bituminous to semi-anthracite to anthracite to graphite, while in some areas deposits of natural coke formed which have been commercially worked.

"Basic Research on Coal" is a very large subject. I propose to limit myself to a discussion of studies normally conducted in laboratories. Discussions of an engineering research nature, such as mining techniques; materials handling; the design, construction, and operation of large power plants; and the construction of pipe lines will not be considered.

Methods for the study of coal are about as diverse as the investigators engaged in its study. Coal offers problems to practically all the disciplines of science, as well as in technology and engineering. A few of the aspects which basic coal research can take, and which I propose to discuss, are: Petrological — coal as a rock; Chemical — its chemical properties; Physical — its physical properties; Utilization — its behavior during use; Geological — its natural occurrence; and Economic — its market worth.

Coal research involves a difficulty not encountered in studies of the other common natural fuels, petroleum and gas, which are essentially homogeneous materials. With a drum of petroleum or a pressure cylinder of natural gas brought into the laboratory, one portion taken for study is the same as any other portion from that supply. However, one piece of coal is apt to be unlike any other piece. One either studies a given piece as a specimen or one studies a finely ground composite sample. The prob-

lems of obtaining a true composite sample, as Virginia mine operators and sales agents know, are extensive and important, and still open to improvement and cost reduction. Coal sampling, correctly carried out, is expensive. Researches to reduce sampling costs can be rewarding. The heterogeneity of coal has led to much controversy in coal research and must always be kept in mind when reading the polemical literature concerning coal origin, composition and behavior during use.

Why this special difficulty with coal? Coal, as mentioned earlier, is derived from deposits of partly decayed plant matter. Such deposits are being formed today, for example, in forest peat swamps. Such deposits consist of leaves, twigs, branches, bark, seeds, pollen, whole trees, and so on, all mixed together. The origin of coal from a mixture of such materials is reflected in its appearance, bright shiny bands of varying sizes intermixed with duller bands which also contain small bright areas and duller areas. The bright glassy pieces are the remains of pieces of wood, with the duller material derived from the miscellaneous mixture in which the wood is embedded.

#### *Petrological Studies of Coal*

To simplify discussion of the gross physical composition of coal, particularly of common bituminous coals, it has become conventional to speak of four "petrographic" constituents described on the basis of their appearance to the naked eye. Consider a specimen of a common banded bituminous coal. The horizontal surfaces will probably be covered with a friable, charcoal-like material which, because of its structural weakness, formed a plane of breakage. This charcoal-like material is one of four commonly recognized components and has long carried the common names, mother-of-coal, mineral charcoal, and more recently in scientific circles, "Fusain."

Looking at the vertical surfaces, one sees bright, highly reflecting glassy layers. These layers, derived from larger pieces of wood, were called by my father "anthraxylon" and by Dr. Marie Stopes, in her classification commonly used in Europe, "Vitrain."

The remaining major portion of the specimen will be a finely banded, non-glassy but still quite bright material, full of small slivers of the glassy type of material. This, in the Stopes system, is "Clarin."

European coals quite commonly contain a fourth variety, a dull, finely banded hard and tough material "Durain," or as the miner tends to call it, "hards." In the U. S., this type of material is present in only small amounts in most coals, but does occur as a major constituent of a few examples, "Brazil Block."



These four petrographic components of coal, Vitrain, Clarain, Durain and Fusain, have quite different physical properties, particularly with respect to breaking strength. They therefore tend to segregate with different size fractions of sieved coal.

Since research has shown that these components also have different chemical properties, and particularly different coking properties, use can be made of the segregating tendency at the mine during preparation of the coal for the market. Such "petrographic preparation" is beginning to be applied in Europe, and is being given increasing attention in this country. Let us consider this petrographic segregation in a little more detail. The first observation made around a coal mine or coal is that the dust is "dirty." This is because Fusain forms planes of weakness and appears on the coal surface where it is subject to much attrition and is easily ground into fine charcoal-like dust. In some coal preparation plants, the fine coal is "dedusted" to make the coal more suitable for stoker use, or for other reasons. This dust which is removed is very rich in Fusain and exists as a potential commercial source if one should want it. Dedusting thus becomes a single form of "petrographic preparation" of coal. Fusain is lower in volatile-matter content than are the other components of coal. Some Virginia low-volatile coals may appear to be appreciably lower in volatile content than their geological position would lead one to expect. This is because of their Fusain contents which may be as high as 15 to 20%.

In petrographic preparation use can also be made of the greater resistance to breakage of the Durain to separate it from the bright coal, and concentrations of each material can be obtained fairly easily by size separation of suitably broken coal.

Fusain, Durain, Clarain and Vitrain are themselves heterogeneous and are made up of a variety of materials related to corresponding units in the plants from which coal was derived.

The glassy Vitrain or anthraxylon, while appearing to be homogeneous, is just as complex as is a piece of wood. In most cases, the original cell structure of the wood is retained, even including the annual rings. The resin inclusions found in wood are still present in the coal.

Clarain and Durain are very complex. In addition to the pieces of woody tissue, there are present leaf cuticles, spore exines, bark and residues of all the other debris found on a forest floor, a lot of it very finely macerated and well decomposed.

These various substances behave differently towards heat, oxidation, hydrogenation, etc. Thus one can reason, if one knew the behavior of



each component and the quantity of it present, one should be able to make a petrographic analysis of a coal and from this predict the value of the coal for a given use, or to predict what mixture of several coals would be suitable for a given purpose.

The astonishingly heterogeneous make-up of coal is first really revealed when a small piece of coal is polished, cemented to a glass slide, and then ground thin until it is translucent. Seen through the microscope, all of the detail of the plant origin of coal is revealed. The various botanical forerunners of coal can be observed in peat, lignite, bituminous coals, and anthracite. Let us consider woody tissue only as an example. Woody material in peat looks like decayed wood; the cell walls are thinner and broken compared to the original wood structure. In lignite, the cells have been crushed; in bituminous coal, they are still further crushed and compacted, but still evident. Most people are astonished to discover that coal in thin section is not black, but is orange, dark red and brown.

It should thus be obvious that one of the more fundamental and important studies of coal should be that of its structural composition from the botanical or palaeobotanical standpoint. Such studies have been underway for more than one-hundred years, and have led to a sound but not yet complete understanding of the composition of coal-forming deposits. We know that different types of coal originated from different types of peat deposits and that the properties of certain special varieties of coal are due to the high proportions they contain of definite plant materials. Cannel coal properties for example, are due to the high proportions of spore exines it contains.

Improvements in sectioning techniques and in optical equipment have made such studies easier, but the most important tool, a good knowledge of botanical structure of ancient plants, can only be obtained by determined study and hard work.

The microscopist is overwhelmed with the structural detail in coal, in spite of the limit to the resolving power or useful magnification of the optical microscope. Yet in recent years, the electron microscope has permitted us to study coal structures far more detailed than those permitted by the limits of the optical microscope. By its use, the incredibly complex structures of cellulose fibers, of wood, of the fine structure of all living matter, has been made even more evident. The electron microscope study of coal shows us that these fine structures of the living plants are still present in coal.

In the previous discussions, we have mentioned the study of thin sections of coal. The palaeobotanist has also taken coals apart by various chemical procedures and has recovered for study some of the more chemi-

cally resistant plant entities for more detailed study, for example, part of leaf cuticles, spore exines, and resin inclusions. In such researches, many spores have been isolated, described and named and in some cases identified as to the plant which bore them. Spores were the reproductive means of the coal-forming plants which today are represented by their descendants, the ferns and club mosses. Lycopodium powder of the pharmacist consists of the spores of the club moss. In coal only the decay resistant outer waxy coats, the exines of the spores, remain. The spores of each species of plant are distinctive and recognizable. Since the vegetation of the coal-forming swamps tended to be homogeneous over their extent just as in swamps today, the spores deposited in the swamp also would be uniform in type throughout its extent. For this reason spore exines can be used for geological correlation of coal beds. Correlations or coal bed identification can be made by making use of the occurrence of a specific spore, of the presence of a predominant spore, or of a given spore distribution pattern, as the characteristic of a specific coal bed. While such correlations are not always completely certain, they are of great help.

Coal can be analyzed in terms of its petrographic components, and such analyses have been compared with the behavior of the coals under conditions of use. The ultimate goal is the ability to predict the use behavior of a coal or mixture of coals from its petrographic analysis. Coal technologists are coming quite close to being able to do this and are making very fast progress. In my opinion, this is one of the fastest growing and most practically profitable aspects of basic coal research at the present time.

Let us therefore look further into this area of coal research and see how petrographic analyses of coal are made and how such analyses are correlated with the use behaviors of the coals to make the analyses commercially useful. However, a bit of caution is needed. Because coals vary so widely in age, rank, type and quality, these methods of evaluation, behavior prediction and control, must be restricted to limited areas of rank and type for which correlations have been established.

Petrographic analysis can be based on the observation of polished surfaces of a series of blocks of coal representing a complete vertical cross-section of the coal to be analyzed. More precise and detailed analyses can be made using thin sections made from similar blocks. Such analyses entail an enormous amount of very skilled work and are expensive, but do give a good indication of the composition of the coal in place.

To apply this analysis to commercially mined coal, one has to assume that any coal obtained commercially by mining the seam would not be changed in composition by the mining process. As we have mentioned, the mechanical processes of mining, crushing, screening, and coal clean-

ing can all affect the composition of the resulting delivered coal. We need therefore a method of petrographic analysis which can be used to analyze coal as delivered in commercial size and which does not require exceptional technical skills. Techniques have been developed by which representative, crushed samples can be tested rather than specimen blocks. In such a technique, for example, a true sample of the coal ground to about the coarseness of granulated sugar is molded, with a suitable resin, into a small block, one face of which is then highly polished. This block is then examined under a microscope, as were the specimen blocks cut from the coal.

The resin-bonded blocks made up of the crushed sample also can be cemented to a glass slide and then ground thin to translucency for observation by transmitted light for petrographic analyses. Such sections are much easier to make than are those from the larger blocks of coal, and for certain routine analyses are quite suitable. More information is available quickly about the coal seam as a whole from their study than from the more painstaking study of sections from the corresponding polished blocks.

Polished surfaces of coal are bright, shiny and reflect light. It is curious and important that the average amount of light reflected from the Vitrain is a function of the rank of the coal, and thus of its carbon content, carbon-hydrogen ratio, etc., and can further be correlated with its behavior during carbonization, combustion, etc. Reflectance measurements are readily made on polished surfaces of coal using a microscope fitted with a photoelectric device which measures the amount of light incident on the sample which is reflected. For routine work, an integrating device can be used which calculates the average reflectance as the sample is automatically traversed under the microscope objective. This method has been highly developed by the Coal Mining Research Institute of Essen, Germany, and has been successfully applied to their selection and quality control of coals and coal blends for coke making.

Petrographic analyses of coals are of particular interest in connection with the evaluation of coals and of blends of coal for metallurgical coke manufacture. Researches toward that objective have been actively pursued in the U. S. and Canada, as well as in Europe. Active centers of such work are U. S. Bureau of Mines, Bituminous Coal Research, Inc., Illinois State Geological Survey, Pennsylvania State University, The U. S. Steel Corporation, Eastern Gas and Fuel Associates, and the Canadian Department of Mines.

The U. S. Bureau of Mines has made extensive correlations of petrographic analyses of coals with their use behavior, particularly effective in the evaluation of coals for hydrogenation. The procedure and the com-



mercially available equipment used by the Bureau has been described in detail.

Correlation, by whatever manner obtained with the actual behavior of a coal during use, is fundamental to the use of petrographic analyses.

### *Chemical Studies*

We have seen that coal is made up of a wide variety of decayed plant residues. One would therefore suppose that there would be materials of a wide variety of compositions present. Surprisingly, the various parts of bituminous coal do not vary greatly in composition. This is because during the coalification process the chemical and physical properties of all the components tend to become similar, and this similarity of composition becomes greater as the rank of the coal gets higher, reaching its ultimate, of course, in graphite. The bright, woody material, infusible in brown coals and lignite, becomes fusible when of bituminous rank, while the resins and waxes become less fusible with increasing rank of the coal in which they appear.

This phenomenon of the melting of bituminous coal is curious and very important. It is this phenomenon which makes possible the production of coke and causes coal to fuse together in a lump when burned on a grate. This phenomenon is still more curious when we consider that lignite and anthracite, below and above bituminous coal in rank do not fuse, and further, that the temperature range during which coal is fused and plastic is small. One of the more fundamental areas of coal research concerns this plastic or fusible nature of coal when heated. What chemical changes have occurred during "coalification" which bring about the property of fusibility in the bituminous coals? This is an excellent subject for research.

We come now to the question, "What is the chemical constitution of coal?" Much effort has been, is being, and no doubt will continue to be expended in an effort to answer that question. Coal being a mixture, we can consider the question from two aspects, (1) what are the chemical compositions of the small homogeneous entities individually, or (2) what is the statistical average composition of the coal. Both approaches have value and usefulness. The statistical average approach is, of course, the one of use in commercial evaluation of coal and is the one generally used. In basic scientific researches, however, there is a growing body of information based on study of a botanical or single petrographic component. The component most frequently used is "anthraxylon" or "vitriinite." Because it occurs in relatively large layers and also because of the way it breaks, it can readily be obtained relatively pure in convenient



amounts for research. Spore exines and resins also have been the subject of special researches on definite components.

An effective scientific attack on the chemical constitution of coal requires many special tools of the various scientific disciplines. Few individuals, if any, are skilled in the use of all of these. This is especially true in recent years which have seen the very rapid growth in the availability of very powerful new tools requiring specialists for their handling and for the interpretation of data obtained through their use. Examples are infrared, ultra-violet and mass spectroscopy, x-ray diffraction, neutron activation, special optical methods, e.m.r. and n.m.r., gas chromatography, physical testing using ultrasonics, and so on.

Perhaps the most concentrated recent attack on the chemical and physical nature of coal using such newly available tools was that by D. W. J. van Krevelen and his associates at the State Mines Laboratories in the Netherlands, which resulted in the book by van Krevelen and Schuyer, "Coal," first published in 1957. After an extensive period of work in which the most advanced methods were used, the magnitude of the effort expended was greatly reduced because Dr. van Krevelen concluded that the methods had been used to the extent of their capabilities, and that further extensive studies should await the availability of further refinements of tools and methods or the discovery of new ones.

What has been learned through the use of these modern techniques? It seems well established that bituminous coals, such as are found in Virginia, are (1) generally carbocyclic or carbon ring in structure; (2) several of these rings are joined or fused together; and (3) oxygen, nitrogen, and sulfur linkages are also present. Based on such information, various investigators have attempted to write a "coal molecule." Such a representation can be only a picture of an average with no assurance that it represents anything that actually exists in coal. However, these pictures have some use in that we can estimate how such a structure would behave on hydrogenation, mild oxidation, heat decomposition, etc.

One has a tendency to consider coal as an inert material, not unlike rock. It is astonishing, however, how reactive coal is under normal atmospheric temperatures. For example, when some coals are exposed to air they react readily with the oxygen. Under conditions where the heat of oxidation is conserved, the temperature of a coal pile, or even a coal seam whose face is exposed, will reach the ignition point and the coal will catch fire, all beginning with oxidation at atmospheric temperature. Coking coals on storage are changed in coking properties due to reaction with atmospheric oxygen, some losing their coking power entirely. Coal will react with hydrogen at atmospheric temperature; in fact, it is possible that reaction with hydrogen under these conditions is the only true hydrogenation

of coal. Reaction under more vigorous conditions at elevated temperatures is considered to cause appreciable molecular degradation and bond breaking, as well as bond saturation.

Coal reacts at atmospheric temperatures with a wide variety of chemicals; for example, with the halogens and nitric acid. Some of the better solvents for coal possibly owe their "solvent power" to their reaction with the coal; for example, the polyethylene amines. Tetra- and deca-hydronaphthalene are active hydrogenating agents for coal and readily act as hydrogen carriers for the hydrogenation of coal. Coal, then, is not necessarily an inert rock; it can be chemically a very reactive substance.

One aspect of coal chemistry that has received relatively little attention but which deserves more, is that of the minor ash forming or non-organic elements. Some elements are present in coal in only very minute amounts and their detection and estimation offer difficulties. The pattern of occurrence of these "minor" elements, specific to and consistent over a wide area of a coal seam, has been suggested as a useful aid to correlation of coal seams where geological structure complexity raises difficulties.

Coal may serve as a source of uncommon elements. For example, germanium appears to have been concentrated in some locations by coal. In Great Britain, germanium so concentrated has been recovered commercially from the flues of coke ovens. Uranium also has been concentrated by wood found embedded in some Western sandstones and also by lignite. The occurrence of uranium in Western coals has been extensively studied by the U. S. Geological Survey. Few really complete analyses for all the unusual elements have been available that our knowledge of their occurrence in coal is quite sparse. The U. S. Bureau of Mines has been engaged in an active program of analyses of a wide range of coals throughout the U. S. for contents of these minor elements, and upon publication of these data, our knowledge in this field will be greatly increased. One can speculate, for example, about the possibility that some one coal may contain a useful quantity of a strategically desirable and relatively rare element. Assuming that the element stays in the ash, its recovery would then be a question of economics or of necessity. A coal carrying such an element could be delivered to one large power plant so that the desired element would be concentrated at one location.

The bulk of coal ash is made up of alumina, silica, lime, iron oxide and magnesia. The recovery of the alumina in coal ash as alum or as alumina for aluminum production has received extensive attention. Large scale studies of alumina recovery by one coal company are underway at present.

The chemical studies directed toward the constitution and conversion of

coal are too complicated for commercial testing and control. Conventionally, coal is subjected to rudimentary tests for the estimation of moisture, ash, "fixed carbon" and sulfur content, heat of combustion, and less frequently for ash fusion point, free swelling index on coking, etc. An important objective of coal research is the correlation of the results of such simple and relatively inexpensive tests with the behavior of a coal for a specific commercial application. The widespread use of such tests is at least a partial indication that much success in such correlations has been achieved.

### *Physical Studies*

In contrast to the simple routine chemical tests, simple routine physical tests are less commonly made. However, the establishment of physical tests as means for commercial evaluation of coals is a rapidly growing and very important area of research. Some of the more common physical tests measure resistance to breakage during commercial handling or the ease of grinding for pulverized fuel firing (for example, the determination of the Hardgroves Grindability Index.)

These physical tests, as well as the common chemical tests just mentioned, give average values for the coal as a whole or a value dependent upon the weakest portions of the coal. The relative physical properties of the individual petrographic components of coal are of greater potential significance. We have mentioned the use of differences in light reflectivity as the basis for a system of laboratory evaluation and process control of coals for special uses. I have also mentioned that the ease of fracture of the various coal components is different and that separation of broken coal on a size basis can result in fractions of different petrographic composition and properties. For this reason the physical behavior of coal components on crushing or grinding to small size should become of increasing interest and importance. The large-scale transmission of coal in finely divided form by pipeline in suspension or slurry systems opens up the possibilities for large scale modification of coal properties by "petrographic preparation." Obviously coal will only be transported by pipelines if such transportation offers economic advantages. The creaming-off of only a small proportion of the feed to a large pipeline could offer a very significant quantity of a special grade of coal, the preparation of which would have been uneconomic if carried on for itself.

The shape factors, surface properties, apparent densities of fine coal, etc., are of importance in such non-power plant processes as fluid bed carbonization and gasification, froth flotation, hydrogenation, etc.

The physics of fracture formation is still imperfectly understood. Fracture formation is of importance in coal mining in the actual release of



the coal from the face, in crushing to commercial size, in pulverization, in roof maintenance, and in such potential uses of coal as in underground gasification. The problems involve not only the power required for breaking but also the control of breaking to give the desired size, shape or position of break.

The permeability of bituminous coal is related to the release of the methane it almost always contains. The flow of gas into the open spaces of the mine is very important from a safety standpoint. What are the effects of cracks formed ahead of the advancing face, how effective are bore-holes ahead of the face in recovering or removing gas, how can gas be more effectively and cheaply removed and recovered? Many problems exist for the physicist in this area.

No discussion of research possibilities in any field today is complete without a consideration of the possible application of atomic energy or atomic physics to the problem. Radioactivity is finding increased use as a research tool. One widely applied use for radioactive materials is as tags on material to be traced through a mechanical or chemical process. The short-lived radioactive gallium-68 has been recommended as a mechanical path tracer for coal since the equipment is radioactively clean the next day. The use of carbon-14, deuterium, tritium, and other radioactive isotopes of elements taking part in a reaction being studied are widely used in studying reaction mechanisms and rates. This technique has been applied with considerable success to studies of chemical structure in coal and the nature and quantity of the reactive groups; for example, hydroxyl or carbonyl a coal contains. Another application of radioactivity which has been applied to coal research is "Neutron Activation" for the estimation of the content of certain elements and for a study of their distribution among the products of a process; for example, combustion or carbonization.

These new tools involving nuclear radiation should be kept in mind when a plan of attack on a coal research problem is being organized. These methods are now at the stage where the availability of commercial laboratory equipment makes it possible for them to be used as tools by those who are not primarily specialists in radioactivity.

Coal is consolidated and metamorphosed decayed vegetation. During decay, many biologically active materials are produced — you are all aware of penicillin and such materials, the modern scientific grandchild of "stump-water for warts." Is there some fossil "stump water" still in coal? It appears that there is, and that it is still biologically active. Report of such biologically active material in coal has recently been made. What more can be found of this nature? Attempts have been made to produce soil-conditioning materials by the action of microorganisms on coal either with or without the addition of nutrients to the coal.



Micrbiological digestion of a sugar has recently been used as the energy-producing reaction in a fuel cell to generate electricity directly from chemical energy. Can coal be substituted for the sugar in a similar cell? Probably not, but one would like to dream that such a possibility exists.

A number of microorganisms use sulfur compounds in their life cycles. It has been suggested that the finely disseminated pyrite in coal had its origin in colonies of sulfur metabolizing bacteria. Can coal be desulfurized by subjecting it in slurry form to the action of an active culture of a sulfur metabolizing microorganism?

### *Utilization Research*

We have so far largely discussed research possibilities concerning the physical properties and chemical nature of coal as it occurs and as it is mined for commerce. Such researches provide the necessary fundamental background for "practical" researches leading toward larger and more rewarding uses for coal. It is these so-called "practical" researches which frequently receive support in preference over more fundamental researches in spite of the fact that expensive empirical studies must be made because of a lack of basic knowledge. In the study of coal, nevertheless, these empirical, "practical" researches have been remarkably successful throughout the world in providing the basis for large industries. Opportunities still exist. The chances of commercial success are governed not only by the nature of the technical solutions of the problems involved, but also by the economic and political climate of the times. Let us look at some examples of the past and then try to uncover some possibilities of the near future for which the economic climate may be improving.

The production of illuminating gas was once a problem occupying the attention of many famous engineers, chemists and technologists, and the artificial, illuminating gas industry was very prosperous. With the invention of the Welsbach ceria-thoria mantle, the "illuminating value" of manufactured gas declined in importance and the aim of gas manufacturing technology was the economical manufacture of a "standard" fuel gas at lowest cost per unit of heating value. In the U. S. today, because of the combination of huge natural-gas reserves and the availability of a tremendous pipeline system, the manufactured gas industry, particularly that based on coal, is almost non-existent. The manufactured gas industry in Europe, still the stronghold of the coal-gas industry, is also now on the decline because of the discovery there of natural gas, the impending importation of liquified methane and the widespread use of petroleum products for gas-making. The favorable economic climate for coal-gas making has come and gone. When will it reappear, and would you invest in a coal-gas plant on the Eastern Seaboard — or anywhere in the U. S.

today? Much thought and study is even now being given to the possible future production of a substitute for natural gas to be made at coal mines and used as feed for the large transcontinental gas lines when the natural gas fields now supplying them are depleted.

Coal as a source of liquid fuel either through direct hydrogenation or by Fischer-Tropsch synthesis from coal-derived gas has been an intriguing prospect, particularly in Europe since the early 1920's. The political and economic climate and war-born necessity made coal-derived liquid fuels important and even essential in England and particularly in Germany during the Second World War. There liquid fuel production from coal was carried on commercially on a large scale. In the U. S., coal liquefaction has been limited to large pilot plant or semi-commercial scale. After the Second World War, coal liquefaction disappeared in Western Europe, but is still active in existing plants behind the Iron Curtain. It is also practiced on a large scale and apparently profitably in South Africa.

The objectives in the past have been the production of gasoline and diesel fuel. A new possibility may now be on the horizon. It is expected that the jet engine powered military supersonic speed aircraft of the next decade or so will place a premium on thermal stability and high energy content per unit volume. Fuels of this character may possibly be produced from coal by hydrogenation as advantageously as from petroleum.

When and where and under what conditions will liquid fuel synthesis from coal once again be favorable?

With these two examples as background, let us look at what some future or near-future possibilities might be for which long-term research would be justified now.

1. Aircraft jet engine fuel for wartime conditions.
2. Blast furnace fuel for tuyere injection, suspended in air, steam or oil.
3. Formed coke or processed fuel for blast furnace top feed.
4. Formed coke or processed coal for non-blast furnace production of iron or steel.
5. Direct production of chemicals from coal.
6. The manufacture of natural gas substitute for pipeline feed when natural gas supplies become sufficiently expensive, using deposits of low rank coals in the West.
7. Underground gasification of coal.
8. "Colloidal fuel," that is, coal suspended in fuel oil so that it settles out only very slowly.

9. Engines burning coal as such, either internal combustion, turbine or free piston engine sets.
10. Conversion of non- or poorly coking coals into coking coals.
11. Rare elements recovery.
12. The mining of coal by solution.
13. Bulk products from coal ash.

Those of you familiar with the history of fuel technology will see little new in these proposals, and that is correct. There is little in modern technology that is really new. The fundamental bases for most new inventions are many years or decades old. New materials, new techniques, new demands, a recognition of the scientific basis behind an empirical device or procedure suddenly change the developmental climate and a new "break-through," to use the term greatly favored, now occurs.

### *Geological Research*

Because of its continued demand, coal has received much attention from geologists and will receive a lot more in the future. The mapping of coal beds, their correlation in complexly disturbed areas, such as in Virginia, and the estimation of reserves in relation to the difficulties of mining have been the classical studies. Some excellent and pioneering work has been done in Virginia, but much more remains to be done.

The structure, stresses and strengths of associated rocks are related to deformations in coal mines as coal is removed. Sudden dislocations or "bumps" are serious dangers in coal mines and the study of their cause and prevention is important.

It has been suggested that the nature of the roof or floor rocks has influenced the chemical nature of the associated coal. Dr. G. H. Cady, formerly of the Illinois Geological Survey, has presented evidence to show that, for Illinois No. 5 and No. 6 coals, where the roof rock consists of gray shale, the sulfur content of the associated coal is considerably less than it is in the more normal areas where the roof rock consists of black shale and limestone. This relationship of an apparently non-marine roof of gray shale to an underlying low-sulfur coal would seem to indicate that the higher sulfur content may be due to a marine invasion. Dr. Cady says further that he has found no indication that the sulfur content is concentrated in the upper part of the beds invaded by marine waters, nor has he discovered that this relationship of roof rock and sulfur content of the associated coal bed is characteristic of coals in other coal fields. In this connection one might also question the relationship of the associated



rock deposits to the occurrence of the minor and unusual elements in coal.

### *Economic Studies*

I am not an economist, and do not presume to be able to state their questions. The economic interplay of alternative fuel sources does seem to me to provide a fascinating field of study. Factors that can be included are costs of production, of transportation, and of use. Great changes are now impending in all of these and more especially with respect to coal than to other fuels for which the costs of production and transportation are already low. What are the economic implications of hydraulic mining, coal pipelines, high voltage, direct current transmission of electric power? How fast will the consumption of electric power continue to grow? What, if any, will be the changes in the requirements for fuel in the iron and steel industry, and how will this affect the competitive positions of the special coals now required for high temperature coke production? How will possible political developments in foreign oil producing countries affect the cost of oil on the U. S. seaboard? The answers to these and many other questions in this area will affect the prosperity of the U. S. coal industry.

### *Summary*

In this review of basic research on coal, I have touched only briefly on some of the more important, interesting and rewarding problems awaiting solution. We have indicated the various ways in which coal can be studied, either with respect to the scientific discipline used or with respect to the objective of the research. These ways of coal research are summarized as follows:

We can study coal as a rock, a combustible rock derived from partly decayed vegetation. We can study the properties of those portions of the coal derived from individual plant entities, wood, leaves, spores, resins, bark, etc., and relate the differing properties of these portions of coal, and the proportions in which they are present to the properties of the whole coal. We may be able to make such estimations by simple physical means.

We can study the chemical properties of coal, either as an average material, by studying true samples in finely divided form, or by studying the chemical composition of the individual components. We can study the mechanical properties of coal, its mechanical strength, its manner of breaking. We can study the physical properties of coal such as its refractive index, its heat and electrical conductivity, its dielectric constant, surface tension density, etc. We can study coal with respect to its intended



uses, for example, as fuel directly, as a raw material for coke, char, gas, liquid fuel, or chemicals.

We can study ways of identifying coal deposits not otherwise readily identified, for example, using samples from exploratory drill cores, isolated deposits, deposits in greatly disturbed geological structures, etc.

Finally, we can study coal for the sheer joy of research to obtain information for the sake of information: how was coal formed, what were the chemical and physical processes involved, what species of plants were involved, what was the source of the minerals and the other inorganic constituents in the coal, what specific plant-derived chemicals can still be identified, etc.

In all this, I have one firm conviction: the study of coal is not a study to be carried out effectively using only one discipline at a time — chemistry, physics, botany, geology, etc., but it must involve the coordinated and intelligent use of many disciplines. As one of my friends working in the field recently told me while discussing material for this paper, one should not be working in the field of coal research if one does not really love the subject; its rewards are too often solely those of the joys and pleasures of a feeling of having made a contribution to science. Many research workers who have served their apprenticeships in coal research have found other fields far more rewarding.

Also during discussions to obtain ideas for this paper, we brought up the question, "What is wrong with coal research in the U. S.?" On this, there seems to be agreement that U. S. coal research has been spotty, on and off at various institutions and dependent upon enthusiasts who have organized groups and programs and kept them going, but who have frequently left no successor to carry on. In consequence, the programs ceased when the enthusiast retired or moved on. The U. S. Bureau of Mines has been most consistent in providing a home and sponsorship for basic coal research in the U. S., and the U. S. coal industry owes a lot to the Bureau.

In closing, I would like to thank and pay tribute to my many friends in and on the fringes of coal research who have helped me by discussing coal research opportunities.

## SOILS

DR. A. GEOFFREY NORMAN, *Professor of Botany and Director, Botanical Gardens, University of Michigan, Ann Arbor, Michigan*

The field of soil science is broad and somewhat lacking in coherence. Most scientists who are engaged in research on soils concern themselves with some sub-division of the subject, usually one based on the particular skills and techniques which they employ. Any discussion of basic research on soils, therefore, is apt to be organized around these disciplinary sub-divisions, even though the underlying principles that are being sought may not align themselves on a disciplinary basis. Moreover, the establishment of principles in soil science through research has not necessarily been followed by changes in land-use. Although the findings of the soil scientist may provide explanations for observed effects, they do not always have discernible impact on land-use. Too often the land has been used or exploited for income or subsistence up to the limits of the knowledge

or capital resources of the owner. This situation has changed and can be expected to continue to change, but even so it is probably true to say that land use is determined more by the climate of current commodity prices than by longer-range national goals; by self interest rather than national interest. The penalty for poor land-use is depleted soil; the result of good land-use is sustained and efficient productivity. In the state of Virginia there are examples of both.

What should we expect of basic research in soils? What is it that we want to know? What principles do we expect to emerge? What use will be made of these principles?

First, we want to know what soil really is. It is an instructive intellectual exercise to attempt to define the word "soil." Most of us end up with a statement describing where it is, and what it is used for. "That frail mantle on the surface of the earth upon which the subsistence of man depends." Soil is a natural body, long in development, reflecting in form and characteristics the substances from which it came and the circumstances under which it developed. What were those circumstances, and how did they result in the soil we use today? What have been the effects of man's use or misuse? What are the changes that may be expected in this natural body if present land-use practices are continued? Would it be preferable to substitute some other management system if sustained productivity is the goal?

Secondly, we want to know what are the properties of soils that relate

directly or indirectly to the requirements of plants, and what, if any, are the effects of the plants on these properties? From the soil must come the water and the nutrients necessary for plant growth. The soil provides the physical environment in which the root system must grow and function. What constitutes a benign environment for the growth of roots? What is involved in the transfer of water and nutrients from soil to plant? Are there adverse factors in soil other than inadequacies in the supply of water and nutrients, or the unsuitability of the physical medium?

### *Soil Genesis and Classification*

The first group of problems involves the study of the morphology and genesis of soils. Although in part descriptive, as is the case with most taxonomic studies, it leads to the development of a system of classification on the basis of natural relationships. These may be most complex because they include consideration of geological origins, past vegetation, climate, time, and the effects of man's use, which last may blur or modify the distinctions that can more readily be made between virgin soils. Chemical and mineralogical information may be made use of in such taxonomic studies, but these in general are subordinate to morphological distinctions between horizons in the profile. Most soil boundaries, however, are not sharp, and the transition areas between distinct soils which may occupy considerable areas, are difficult to accommodate.

There is currently under way in this country a brave attempt to devise a new comprehensive system of soil classification that will accommodate all soils. This involves the designation of categories in a hierarchical arrangement based on the weight to be placed on the characters involved. It still leans heavily on the recognition of the virgin soil condition, which, when considering agriculturally young soils, is perhaps not a serious objection, but is less useful or even futile when applied to soils long cultivated, as in western Europe or even Tidewater Virginia, or to soils heavily eroded or transported by water. It has often been said that a natural classification should be based upon measurable properties, but in fact this does not seem to have progressed much further with soils than with plants, the separation of which often depends upon trivial morphological characters. The research effort going into problems of classification is not large.

Classification in turn leads to mapping, and maps are intended to be used. Detailed soil maps are expensive to prepare, and, if based on a natural classification, have severe limitations in interpretation. Many of those who concern themselves with soil classification based on genesis and morphology do not wish to weight their judgments with considerations relating to specific uses. But, answers to many important questions about land-use and management can only be ventured if additional informa-



tion is available. This means that there has to be a second echelon of soil scientists facing the more applied issues. Some may be chemists or physicists who will attempt measurements that specifically bear on the capacity of a soil to supply nutrients and water. Others may be specialists in the ill-defined field of soil fertility who must acquire their information by empirical experimentation and observation. Too often in their experiments they attempt to study single factors in multi-factor situations. This is not basic research.

I have spoken of the current attempt to devise a new system of soil classification, because of the need which we saw for an answer to the question "what is a soil"? Some of those working in this field believe that their efforts and opinions are basic to the whole of soil science. Others who are concerned primarily with properties of soils as affecting soil-plant relationships regard much of this as peripheral, because they do not believe that even the most elaborate taxonomic information necessarily carries with it logical deductions as to management and use.

### *Soil Water*

It has already been pointed out that much of soil science arranges itself on a disciplinary basis. The relative emphasis between disciplines changes from time to time. The chemistry of the soil in relation to the supply of nutrient ions, which for a lengthy period was the dominant disciplinary field, seems currently to occupy a lower place in basic soil studies. The physics of the soil in relation to the supply of water and to the atmospheric environment of plant roots has displaced it as the most vigorous field of investigation. Soil microbiology, that perennial stepchild, has largely been transformed into soil biochemistry, but the soil microbiologists have not yet successfully convinced their colleagues in soil chemistry and soil physics that the presence of organisms and the products thereof must be taken into account in all soil processes.

In many parts of the world the adequacy of the supply of water to the plant during the growing season is a major factor in productivity. Therefore, the entry of water into the soil, its storage in the root zone, and the rate of transfer to plant roots are vital questions in soil science. The basic physics of water in soil is highly complex, and although there has been rapid progress in recent years, most soil physicists are not yet satisfied with the present state of the theory or the techniques of measurement. Most soil physicists in fact have not yet got to the point of considering the plant at all, or of analyzing the situation in the immediate vicinity of plant roots.

Soil has a very large internal surface, much of which is physico-chemically active. The pore system, and therefore the porosity of the soil,



depends in part on its texture and the size distribution of the soil components. In saturated soils where there is only a two-phase system to consider, the water is held very weakly and can drain out by gravity, but in unsaturated soils, where there is a three-phase system, water flow is more difficult to analyze. Some pores may contain water, others contain air. The forces with which water is retained increase inversely as the water content. These can be expressed as a suction force, and the retentivity then is the water retained by a soil at a specified suction pressure or tension. An important advance has been the development of methods for determining capillary conductivity or hydraulic conductivity over the range of soil moisture levels suitable for plant growth.

One of our distinguished soil physicists, L. A. Richards, states that "Both laboratory and field measurements indicate that the capillary conductivity function is a true physical property of soil." It has been the goal of soil physicists to develop equipment or apparatus that does yield basic information of this sort, rather than empirical information, which though useful in comparisons between soils, is not interpretable in strict physical terms. An example of the latter might be the wet sieving methods of developed for the study of aggregate stability.

The application of radiation and radioisotopes to soil physics research in recent years has been rewarding, and is likely to be increasingly so as procedures of greater sophistication are devised. The water retained in soil in the field can be determined by neutron scattering using a source of fast neutrons (radium and beryllium) lowered down a pipe previously driven into the soil. The measurement applies to a zone about 6 inches in diameter and enables relatively rapid determination of the moisture level at different depths, because the slowed neutrons detected are essentially proportional to the number of hydrogen atoms present in the soil water. This device can be applied also to gross water movement studies in irrigation and drainage, or to the determination of evaporative losses. Miniaturization of such equipment may well extend its range of applicability.

Radioisotopes such as deuterium and tritium have also been used effectively in the study of the movement of water in soil, both under unsaturated and saturated conditions. The unsaturated conditions provide the more difficult theoretical problems, but, of course, are directly applicable to events in the vicinity of plant roots. Information obtained under saturated conditions applies to grosser problems of ground water flow. Some caution is necessary in the interpretation of data obtained with heavy water in soil, however, because of exchange with the surface hydroxyls and lattice hydroxyls of the clay minerals. Soil water is a reactive medium not an inert fluid surrounding inert particles.

### *The Soil Atmosphere*

The soil atmosphere is in need of more intensive consideration. There is an obvious inverse relationship between the water content and the air content of a soil which means that the composition of the air and the rates of gaseous diffusion are affected by the water content and distribution. The metabolic processes in the roots of most species of plants are highly aerobic and therefore oxygen dependent. An inadequate supply of oxygen, such as occurs when gaseous diffusion is restricted, has immediate effects on root growth and root function. An oxygen content well below that of normal air will support good root development provided that the rate of gaseous diffusion permits sufficiently rapid replacement. The pore size distribution and the geometry of the water film distribution are both important factors in the diffusion process, the physics of which has been less well studied than that of soil water movement. When the oxygen supply to the root is inadequate, the rate of utilization by the root is controlled by the rate of diffusion. The latter is little influenced by temperature whereas metabolic activities in the root are highly temperature-dependent. Soil temperature, therefore, is a factor in the adequacy of oxygen supply. Again in these studies there is the possibility of using isotopes such as oxygen 18, nitrogen 15 and  $C^{14}O_2$ . Determination of the first two by mass spectrometry requires that the sample size be considerably larger than with radioisotopes.

### *Soil Chemistry*

Turning next to the chemistry of the soil it is necessary to point out that the early and classical approach was an analytical one with the primary goal the determination of its gross composition. This gave way to the intensive study of the essential nutrient elements in soils in order to ascertain their primary sources, and the chemical events that are involved in their availability to plants. With some ions the story is relatively simple but with others the transformations are extremely complicated. The important information may center round the rate of conversion to an available form, which may not be easily determined. Considerable success has been achieved in devising empirical extraction procedures that correlate reasonably well with availability, and are widely used in so-called soil testing laboratories in order to predict the profitable level of supplementary fertilization. All in all, however, soil chemists have reasonably complete information about the chemistry of the major and minor nutrient elements. The basic problems that remain to challenge the chemist may seem further removed from the welfare of the plant. Many of these center round two groups of soil components, the clay minerals on the one hand and the humus or organic matter fractions on the other. Both these groups

are physicochemically active so that interactions between them are possible.

The clay minerals, which are crystalline in the sense that in them there is regularity of arrangement of atoms, are built up in layers with the silicon and aluminum atoms as the essential structural units. The structure of clay minerals is dominated by the layers of oxygen atoms attached to silicon and aluminum; the metal ions merely fit into holes between the oxygens. Isomorphous replacement can take place freely, subject to steric limitations, with atoms such as aluminum, iron or magnesium replacing silicon or aluminum. This has important effects because such replacements result in a net negative charge, which can be neutralized by larger cations, such as calcium and potassium, held on the surfaces or between the packed layers of the minerals. This leads the chemist into deep physicochemical waters. Much that goes on in soils depends on the nature and condition of the clay minerals and the relative strengths with which cations are held by them. Procedures for identifying particular minerals with reasonable certainty have been developed, but are in need of improvement. The difficulty here, of course, is that this is not a matter of recognizing definite compounds in a mixture, but of identifying types within which there is a good deal of variation.

With the acquisition of a more complete understanding of the local chemistry of the clay minerals there will be significant pedological dividends, inasmuch as the clay minerals are in effect synthesized *in situ* as a result of the chemical processes due to weathering. They reflect not only the parent rock materials but also the conditions of weathering. There will also be dividends that relate to management and usage, because different minerals exhibit characteristic properties.

The long-recognized property of soil acidity which has enormous ramifications in soil genesis, soil fertility and plant nutrition is still not satisfactorily covered by theory. There are good reasons for believing that the acidity is not due to exchangeable hydrogen ( $H^+$ ) but to aluminum ( $Al^{3+}$ ) released from the clay lattice and subsequently adsorbed on the faces and in interlayers. Here also there may be deposition of hydroxides and monomeric silica.

As for soil organic matter one has to say that this currently is not a substance that is receiving much attention by soil chemists. Indeed there is more than an inclination to leave its complexities to the soil microbiologist on the ground that, if he can identify the substrate and the organisms involved, it should be possible for him to follow the transformations through to a recognizable end product. Soil organic matter chemistry has not yielded much to the direct assault of the chemist; even the new tools of chemistry have not resulted in great gains. There are good reasons why this has proved to be such an obdurate topic. The plant residues which form



the substrate are complicated mixtures, the synthetic activities of microorganisms bring about further elaboration, compounded in complexity by the circumstance that these transformations proceed in the presence of clay minerals with highly active surfaces. Because of the multiple roles of humus in soils this is, however, a basic problem in soil chemistry, which one day must yield to some new approach.

Although some use has been made of the nitrogen isotope  $N^{15}$  in decomposition studies the objectives in such experiments have primarily been quite short range, such as the determination of mineralization rate or the conversion of inorganic nitrogen to the organic form. There are unexplored possibilities in studying the chemistry of the humus residues from plant tissues tagged with  $C^{13}$ ,  $C^{14}$ ,  $N^{15}$ , deuterium, and the like.

### *Microorganisms in Soil*

The field of soil microbiology is not being vigorously cultivated at present. Among soil scientists one could get divergent opinions as to the significance of work in the field, and to the dividends that might follow an intensification of basic studies. The microbiologists would be able to point to a host of biological problems awaiting attention, most of which might not be highly rated by their colleagues in other segments of soil science. Soils characteristically contain a diverse microflora and fauna; this fact ought indeed to be included in any definition of soil. Perhaps some microbiologists have been at fault in over-emphasizing the dependence of plants on the activities of the other soil inhabitants, whereas in fact the higher plants and the soil inhabitants are interdependent in varying degrees. Plants may be supposed by some of the products of the activities of microorganisms; conversely the soil population is dependent directly or indirectly on higher plants for energy sources.

As I would view the promise of basic work in soil microbiology in the context of soil science, it might depend on the degree of joint participation of physicists, chemists and microbiologists in their mutual problems. The phenomenon of water flow in soil cannot be approached realistically unless it is recognized that the water film over clay particles, the contract rings between particles and at times the water in the smaller pores all contain clusters, colonies and clumps of organisms and fungal hyphae that surely must affect water movement, particularly under conditions of unsaturated flow. Similarly the circumstances on the surfaces of clay minerals must be affected by organic coatings and adsorbed products from the activities of microorganisms, as well as by the organisms themselves in the overlying water film. Calculations on the composition of the soil atmosphere, based on diffusion rates only, are apt to be in error unless it is recognized that soil organisms also cause depletion of oxygen and evolve carbon dioxide. The microbiologist then must plead with his colleagues in physics



and chemistry not to rely too heavily on over-simplified systems lacking microorganisms and the substrates that support them. Conversely, as F. E. Allison recently said, there is "a need for microbiologists to make a more determined effort to relate their work more closely to the soil and the plants."

### *Soil-Plant Relationships*

This brings me to a final point, namely that many soil scientists seem most reluctant to concern themselves with vital soil-plant relationships. A science of the soil without reference to plants would be sterile. These relationships are not to be left to the plant physiologists, some of whom have never come out of the dream world of nutrient solutions, or to the crop scientists, many of whom are preoccupied with crop improvement through breeding. Chemists, physicists and microbiologists alike must think more about plant roots and include roots in their experimental systems. The microbiologist is perhaps in advance of his colleagues here in his current emphasis on microbial events on root surfaces or in their immediate vicinity in the rhizosphere.

Comparative studies of water flow and entry into roots are needed, and analyses of the diffusion of gases from the soil voids into root cells, and of the flux of ions from the ionic shells round the clay minerals into the free space and tissues of the root. Some brave starts have been made, but much remains to be done to provide a clear picture of the traffic pattern at the root-soil interface.

Some of you will note that I have ignored the technology of soil science and have said nothing of management practices. Undoubtedly there will be technological changes and modifications in practices. The nature of these, however, will depend in great measure on the goals of the time. They could arise for various reasons. I would hope that some would come because of a decision to treat our soils as a vital natural resource, not to be impaired or dissipated but to be farmed efficiently, so that two other resources, manpower and water, are not wasted. Agriculture in our economy, and in much of the western world, is in a phase of rapid change. Per acre yields have risen sharply, partly because of realization of the fact if production is concentrated on the better soils the returns for a given input are higher. We may end up with a system calling for the most intensive level of use of soils compatible with the maintenance of continued productivity. Here it is that the basic knowledge that will emerge must be applied. We will need to know what is the most intensive use that can safely be imposed, but in order to do this we will have to be able to determine small changes or trends before they have gone irretrievably far. Once the theory is known, predictions can be made with some confidence.

It would be wrong to suggest that all information obtained through basic soil research will be found to have application in practice. But, as bits and pieces of information are obtained, they are apt to fall and fit together so that the picture becomes clear. The investigator may not know at the time where his little piece should go, but he has deep conviction that sooner or later its place will become apparent, perhaps not to him but to some colleague in the community of science, somewhere, sometime. In basic research, this is "the spur that the clear spirit doth raise."

## FORESTRY GAINS FROM BASIC RESEARCH

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This will not be a talk on Virginia forestry as such. Rather it will deal with why what we call basic, or fundamental research — research often seemingly remote from practical application — is vital to the development of Virginia's forest resources. When we say Virginia's forest resources, I wonder how many of you realize what they include. Everyone thinks of wood, but that is only one of many forest resources. The forest also governs our water supply, determines our game supply and our inland fishing, provides range and protection for cattle, and gives us our greatest areas of outdoor recreation. This multiple use — the motto of the U. S. Forest Service — multiplies the problems in forestry research, because each use must ultimately be harmonized with the other uses.

The forest industries of Virginia rank third in annual income provided in the State — \$833,000,000. In North Carolina, the forest industries are secondly only to tobacco. The forests themselves cover 63 percent of Virginia's land surface. The products of the forest — wood, water, forage, etc., are all renewable. When we use them but not abuse them, they return to be used again and again.

Until quite recently, almost all forestry research was of the applied type. The system of Experiment Stations of the U. S. Forest Service has conducted most of this work, with the universities, state agencies, and forest industries more recently taking a rapidly increasing share of the load. Exigencies and problems demanding early solution have dominated research planning, so that work in such basic fields as soil microbiology, or nematodes, or the physiology of flowering and fruiting has been repeatedly pushed aside or deferred time and again. Forestry has depended heavily on research on agricultural crops to supply basic knowledge in physiology, genetics, soils, and many other disciplines. But the forest crop is not replanted every year. Its soils are not plowed up every year or fertilized every year. Forestry has problems peculiar to this field, and we cannot develop all of our research principles from those of the cotton or corn scientists. In the forest, the soil flora, the lesser vegetation, and the trees must stay in constant association with each other for 50 to 200 years before harvest, thus intensifying their effects upon each other. Thus we have problems develop in time that do not touch the grower who starts his crop over again each year.



Forestry has finally made a strong bid to get into non-applied research in a big way — to start putting something in at the bottom of the knowledge barrel, so we can keep drawing off practical solutions at the top.

The Southeastern Forest Experiment Station, with which I am affiliated, maintains field units at Charlottesville, Farmville, and Franklin, Virginia. We have many additional units ranging as far south as Fort Myers, Florida. Within the past year we completed a new, well-equipped laboratory building near Lake City, Florida, and one in the North Carolina Research Triangle near Raleigh — the latter oriented toward basic research. We occupy modern fire and seed laboratories at Macon, Georgia, and a new research building is under construction at Athens, Georgia. These laboratories are being equipped with the latest in experimental facilities, including climate-control rooms, ultra-microscopes, and means for or access to facilities for radiation and the use of radioisotopes. Several southeastern universities also have greatly increased the basic phases of their forest research programs.

There are many definitions for what we call basic and applied research these days, and many scientists and writers can generate quite a bit of steam over what they consider the correctness of the distinction. Others figure that any attempt at a distinction is a futile. I believe that we might dispense with precision with such an intangible subject and accept a working separation. Research is basic so long as it does not *necessarily* have any ready application to man's welfare at the time the research is done. If it is done with a specific practical goal in view, then it is applied research. The same piece of work can thus be basic or applied, depending on the philosophy of the worker.

Hence, if an entomologist measured the rate of wingbeats of a mosquito simply because he was interested in wingbeats, the research was basic. If he did it because he thought he could make wingbeats of a given velocity trigger an anti-mosquito repellent, the same research was applied. How difficult research is has no connection with whether it is basic or not. Studies of a highly complex nature requiring top competence are now referred to as sophisticated research.

Applied research, by my definition of it, has the best chance of solving man's immediate problems in the shortest time because it is directed right at an applied goal. It is what we call problem-oriented. This is fine so long as man knows what his problems and goals are. Thus, too many of our physical scientists and engineers might have been expending their energies on the applied problems in making dishwashers, garbage disposals, and silent toilets, while they were unconcerned with the subject of rockets. Suddenly rocket knowledge became imperative, and we had little background for it. Our men had been working in *practical* research. Had



enough of them delved more into abstract mathematics, astrophysics, and rocket engineering, which a few years ago would have been considered very basic research, we would have had a greater fund of knowledge basic to rocketry when we needed it. Thus, the basic or fundamental scientist says, in effect, "I will uncover new facts, new truths, or new relationships in the fields of my competence. Who is to say when, or in what way, man may make use of my information."

Basic research attracts creative minds. It attracts scientists who want to be able to let their minds and their labors follow any course that promises interesting new knowledge. Of course in addition to the superior type of basic scientist, we also have the dilettante — the fellow who is really a tinkerer at heart, enjoying his hobby at someone else's expense. We like to believe that we can recognize him and avoid him.

The serious search for truth, which is what science is, is most difficult in the biological fields. Forestry is a field in which we fight hard and long for every scrap of new knowledge. We still do not even know how water gets to the top of tall trees, or just what lignin is. We still have to helplessly witness a tree disease completely wipe out the chestnut — Virginia's most versatile tree. Catastrophic fires still start, rage and cause enormous losses in the West and South. I could cite many other examples of problems that are still with us and that one might expect we would have solved by now. Why is this?

We deal with essentially wild land. Many principles that we could make use of under such intensive management as is given a good farm or orchard do us little good in forestry. Take spraying — if we had to spray whole forests several times a year to produce wood that we could use, as the orchardist does for his apples, within a few years the spraying would have cost more than the wood was worth. If we had to add lime and fertilizer every year to raise pulpwood, we would not be in business long.

Successful forestry requires getting nature to work for us. If we use the right species composition, our soils will stay fertile. If we don't, they will deteriorate. If we lay out logging roads and do our skidding properly, we will not create erosion problems or damage water values. If we use seed from superior parents, we will usually get superior planting stock. In each of these cases, the forester makes his decision, set events in motion, and nature does most of the rest. If a farmer makes a mistake, he can often rectify it the following year. He can change his crop, his fertilizer, and his cultivation practices annually. The forester might not know until the fifth year after planting that he planted a rust-susceptible species of pine; or until a cold 15th year that his seed came from too far South.

Since we cannot correct our mistakes easily, and since what we do we do on large areas of land, it behooves us to make correct decisions. Much of our applied research in forestry tells us what will happen if we do a given thing at a given place at a certain time. Such work usually does not establish principles that can be applied very generally. I will give you an example. One of our men who manages a southern Piedmont forest can get abundant pine regeneration no matter what reasonable silvicultural system he follows. The encroachment of hardwoods is not serious with him. But on another of our Piedmont forests further, most of these same methods result in an unwanted hardwood forest in a few years. These researches were of the applied type. Each produced an answer useful only under the conditions of the experiment.

In contrast, an example of basic forest research that applied to the Piedmont is the work on the calcium content of foliage and forest soil productivity. Trees vary greatly in calcium content of the leaves, from 0.2 percent in pine needles to 4.0 percent in the leaves of some hardwood species. Research showed that the trees with low calcium, such as the pines, generally depleted the soil on which they grow, while those with high calcium, such as many hardwoods, built up the soil. Under the pines, one was likely to find low organic matter, poorly incorporated, and with low biotic activity; while under the better hardwoods, one found soil high in organic matter, well incorporated, of good tilth, and with a good complement of earthworms and other desirable biotic activity. Findings from this kind of "basic" research can be applied widely, and are the basis for much of our thinking on the important role of some of the much maligned hardwoods in maintaining the productivity of forest soils.

I would like to give you some other examples of what the pursuit of basic or fundamental knowledge in forest science will ultimately mean to the solution of some of Virginia's forest and wood problems.

### *The Forest Nutrient Cycle*

Soil is as much a part of the forest as the trees and other vegetation growing on the site. It anchors the plants, functions as a storehouse for the water and nutrients needed by vegetation, and has a host of other functions. In a natural state, vegetation can come and go but the soil remains to produce more in the future. When man begins to work the land, quite a bit of the soil does not stay in place. A lack of appreciation of the soil resource and the extent to which it can be ruined by abuse has brought about many of the problems we now face in forestry.

The forest is a vast storehouse of nutrients — they are present in all parts of the vegetation, in the organic debris called the forest floor, and

in the soil. The forest floor, made up of the organic debris covering the mineral soil, not only stores nutrients, but it also functions as a blanket to protect the mineral soil, and usually consists of from 4,000 to 30,000 pounds of organic matter per acre. It slows down erosion, insulates the mineral soil, and ameliorates the microclimate so that excessive temperatures and evaporation from the mineral soil are held to a minimum. The forest floor plays an important role in many other phases of the life of the forest, as an environment for roots, for helpful soil organisms, and as the arena for the biological and chemical activities that feed our trees. It may also harbor diseases and insects that attack trees. It may store water temporarily, function as fuel for fires, and even prevent seeds from germinating.

Intensive studies are now underway on the function of the soil fauna in the breakdown of forest litter, that is, leaves, twigs, dead wood, etc. These organisms are small, making up in numbers what they lack in size. For example, a handful of forest litter may easily contain 1,000 soil mites alone — animals living, eating, reproducing, and dying in the bit of material held in your hand, yet hardly visible to the naked eye.

When we know how these animals and also the fungi, bacteria, yeasts, and actinomycetes exert an influence on the disintegration of forest litter, we will have made great strides in uncovering some of the great unknowns in forest nutrition.

Under natural conditions, the nutrient supply of the forest is used over and over, and this is called the nutrient cycle. In sharp contrast are agricultural soils. Here there is a nutrient cycle, but it is so disrupted by man that the components must be continually replenished.

The nutrient cycle of the forest is also broken by man. This can be a minor break such as when a few trees are cut, or a drastic break if an area is clearcut, burned, and eroded. Aside from these man-made losses there is a gradual depletion of solutes due to leaching, washing, and normal geologic erosion. Compared to these losses, the additions are quite small — these additions are the nutrients carried down in rain water, and those slowly converted to usable form as the parent material decomposes to form subsoil.

With the exception of nitrogen, plants add no nutrients to the site — they merely redistribute them from the lower horizons to the surface. The continual drain on the nutrient capital of the forest is going to cause us trouble. In Europe, where forestry is centuries older than here, decreased forest yields in many timber stands are attributed to soil depletion. To solve this nutrient drain problem, we must first know the location of the nutrients in the forest. How much is tied up in the logs we remove?



How much is returned to the forest in litter fall, and the debris left after an area is logged? How much is held in the forest floor, or organic matter on the surface of the soil? We already know that the nutrient cycle varies greatly between pine and hardwood stands, as I have already mentioned with respect to calcium. Ultimately we must be able to manipulate the forest vegetation to bring about a favorable nutrient cycle. We are now actively engaged in nutrient cycle studies, and expect this research to pay big dividends.

### *Research in Tree Diseases Pays Off*

In the field of plant pathology we have had some very damaging and very baffling nursery diseases. The South raises far more nursery stock (about a billion trees a year) than the rest of the country put together. One of our major root diseases was particularly difficult to solve because two different fungi, as well as nematodes, appeared to be involved. At one nursery the use of a soil fumigant, ethylene dibromide, that destroyed only the nematodes checked the disease. At other nurseries this treatment had little effect. Knowledge of the selectiveness of certain fumigants thus pointed to the involvement of organisms other than nematodes. Pains-taking research disclosed that two soil-borne fungi could also bring about this root disease without even penetrating the roots — simply by the secretion of a toxic principle. As a result, we went to methyl bromide as a fumigant, a gas that kills not only nematodes, but soil fungi as well. The results have been spectacular in providing complete control of root rot, nematodes, and other soil invaders plus bonuses of weed control and a fertilizing effect that produces uniform high-grade seedlings. Methyl bromide fumigation is now in wide use in the South.

I wonder how many of you have heard of a mycorrhiza. Mycorrhizae are root structures made up of rootlet tissue surrounded and invaded by helpful fungi forming a symbiotic relationship. They are the main feeding structures of the southern pines, forming a sort of supplementary root system. The tree gives the mycorrhizal fungi mainly carbohydrates, and in return receives special nutrient supplies from the soil by means of these fungi.

However, in addition to nutrition, there is another aspect to this benefit afforded trees by mycorrhizae and one which has long been ignored. This is the role of mycorrhizal fungi in warding off attack by root pathogens, such as the parasite *Phytophthora cinnamomi* and other soil fungi. Our studies indicate that mycorrhizal fungi produce various antagonistic responses to *P. cinnamomi* when grown on nutrient agar. For example, this pathogen completely outgrows and overruns the soil fungus *Amanita muscaria* but is itself severely inhibited when grown with a mycorrhizal



species of *Boletus*. A fungus obtained directly from a slash pine mycorrhiza completely halted the growth of the root-killing fungus *P. cinnamomi* when placed an inch away.

Unthrifty and often failing plantings of forest trees in areas previously not forested and lacking suitable mycorrhizal fungi in the soil have been retrieved by simply adding a small quantity of soil or duff from a forest area to the soil. Before long, mycorrhizae appeared on roots, and growth and vigor became normal. Many have interpreted such improvements as related to improved nutrient absorption by the now mycorrhizal root system. Yet many of the soils planted, such as those of the shelterbelt areas of the Great Plains, were high-quality agricultural soils and contained much higher levels of nutrients than most forest soils.

Rather, we believe that, on many such soils, growth improvement following mycorrhizal formation probably resulted from the protection from disease organisms afforded roots by the fungus component of their mycorrhizae. It is difficult to visualize a tree root system equipped only with succulent root tips and root hairs and no mycorrhizae, thriving and escaping infection by pathogens, and unaffected by toxic secretions of microorganisms in a biologically active soil.

#### *Virus Diseases Destroy Damaging Forest Insects*

One of the most far reaching discoveries resulting from basic research in forest entomology was the isolation of pathogenic viruses from the bodies of destructive insects. Subsequently it was learned that viruses could be stored and cultured and then diluted for application against the damaging insect.

The important work in this field in the East was done with the European pine sawfly. A polyhedral virus disease was isolated from a few dead larvae obtained from Europe, where the sawfly is naturally controlled by polyhedrosis disease. The supply of virus was built up and subsequently released by both ground and aerial applications over sawfly-infested areas in New Jersey. A high degree of control was obtained. This virus also persists in sawfly populations treated with it.

Since this pioneering work there has been an increasing emphasis in research on viruses as well as many other microbial disease-producing organisms affecting destructive forest insects. Microbials are being found in many forest insects. For example, the Virginia pine sawfly was recently epidemic over an area of 14 million acres from the Piedmont of North Carolina into Maryland. Of 2½ million acres of pine damaged by the insect, about 2 million acres were in Virginia. This attack has subsided. Recently a virus recovered from field collections of this insect was tested

against it and found highly effective. Entomologists will be ready to use it when this sawfly again becomes epidemic.

### *A Basic Approach to a Fire Problem*

Virginia has a very fine forest fire record. In 1960 only 0.05 percent of its forest area burned. However, in the South as a whole there have been many fires that burned 200,000 acres or more in the last few years. Research on fundamental factors which govern uncontrolled fire is currently being pursued with the use of what is called a "steady-state" fire model. The model consists of a crib made of wood of known physical properties which is burned on a special table in a combustion room. The table and combustion room are instrumented to measure several dependent factors, such as radiative and convective heat, flame dimensions, convection column temperature, and rate of spread.

Results of these experiments are expressed in terms that enable one to scale from model to prototype. Results of burning these models thus far show the effects of kind of forest fuel, its moisture content, and depth of fuel bed on rate of spread and fire intensity.

Crib fires will be burned in our wind tunnel using the steady-state technique to determine the effect of wind on fire spread and intensity. These studies will tell our fire specialists things they have needed to know about the basic laws of ignition, flame development, and rate of energy release from different fuels under different weather conditions. This knowledge will mean better preparation for fire control planning, to minimize the danger of disastrous fires.

### *A Fundamental Discovery in Forest Hydrology*

One of our Station's most important findings in recent years from research in watershed management is evidence that slow drainage from unsaturated soil can sustain the flow of small headwater streams during dry spells.

It has been generally assumed that the water retained in a soil, when it reaches "field capacity," a few days after a heavy rain, can be lost only to the atmosphere and hence contributes nothing to streamflow. However, since the occurrence of extensive ground water bodies could never be demonstrated at our Coweeta Hydrologic Laboratory from observations of ground water wells over a 25-year period, one could wonder from whence comes the water that sustains streamflow in long drought periods. It appeared that slow drainage from deep soils operating for long periods after rainfall recharge must be the source of the low flow of Coweeta streams.

This was experimentally verified using a large, sloping soil model pro-

vided with an artificial sand-gravel "water table." After fully soaking the model, as under sustained rainfall, it produced measurable outflow for an ensuing period of 140 days; and precise measurements confirmed that the outflow for the last 138 days was slow drainage from unsaturated soil upslope from the water table. Quantitatively, these outflow rates when expressed in terms of the soil volume of the Coweeta watershed are in close agreement with the observed dry-weather flow of gauged streams.

This confirmation that base flow of mountain streams does not come entirely from extensive ground water supplies affords important clues for water managers. It shows that some of the water that feeds the flow of streams drains from quite remote mountain slopes where it is subject to day-to-day evapotranspiration loss and can hence be controlled by manipulating forest cover. This greatly extends the possibilities of watershed management with respect to improving water yield.

### *Forest Physiology Offers New Tools to Research*

Let me give an example or two of how basic research in physiology is contributing to the solution of a practical forestry problem, as well as suggesting promising lines of research for plant physiology in general.

It has been known for some time that applications of nitrogen fertilizers often stimulate seed production in southern pines, although the role of nitrogen in this flowering and fruiting is largely unknown.

New studies of the nitrogen fractions of loblolly pine flowers, conelets, and cones show that more than half of the soluble nitrogen is in the form of arginine, and that arginine was the major component of the soluble nitrogen in the younger twigs (on which flowers and cones develop).

Assuming that we may well want to increase the arginine content of pine tissues to stimulate seed production, it is interesting to report that the amount of free arginine in loblolly pine seedlings was increased approximately 20-fold by using ammonium or urea as a nitrogen source instead of nitrate. The complete explanation of how the increase in arginine is brought about has not been found. However, we know from analyses of loblolly pine xylem sap that most of the nitrogen is in the form of glutamine. Thus, nitrogen fertilizers applied to the soil are transformed, in the roots, to glutamine before being translocated upward in the xylem. Radiotracer studies have confirmed glutamine synthesis in pine roots and stimulation of synthesis by added ammonium or urea. Our new knowledge on forms of nitrogen, their uptake, translocation, storage, and functions is operating new doors to our goals in increasing seed production.

In the field of plant physiology we are learning how to grow undifferen-



tiated plant tissue in test tube cultures. A piece of root or stem tissue from a tree can be implanted on agar and have its cells multiply like cancer cells producing a formless wad of root cells or stem cells. As soon as this technique was developed, innumerable uses for it occurred to investigators, including a short cut to testing for rust-disease resistance by inoculating these tissue cultures rather than growing trees.

### *Silviculture Gets Big Boost from the Basic Approach*

Work recently carried out in part at the Eastern Seed Tree Laboratory in Macon, Georgia, has resulted in breakthroughs on controlling forest tree seed germination. Previously, germination could only be hastened by physical means; that is, stratification, watering schedules, and the like.

Recently, the use of chemicals to control seed germination has been successful. Hydrogen peroxide and several organic acids have increased the speed of germination of a number of forest tree species. For example, loblolly pine has been germinated as rapidly with citric acid applications in two or three days as previously with stratification that required a 90-day period. Eastern redcedar germination has been increased from 10 to 80 percent by immersing in weak acids.

This type of treatment offers an entirely new field of controlling the speed of germination for planting and direct seeding operations. It should soon be possible to prescribe the germination treatment to be given a batch of seed to minimize the effects of predicted droughts, migrant bird invasions, and rodent feeding.

Another startling strike in understanding pine seed germination has come from studies of the effect of exposing seeds to light. In the past it has been considered essential that pine seed not be covered with soil if reasonable success in germination was to be obtained. No one knew why. This meant that these seeds could not be drilled into the soil like corn but were sown on the surface, subject to consumption by birds and animals, and so often to death of the exposed germinating seedling by drought.

Working with celery seed, physiologists found that *their* failure to germinate when covered was due to failure to meet a light requirement. Who would have expected that a seed would need light to germinate? When this knowledge was applied to pine seed it was found that if moistened seed are given a short exposure to light, they can then be covered with soil and will germinate. Thus, what we call direct seeding, as opposed to planting nursery-raised seedlings, has emerged from the doghouse of repeated failure to one of our best and cheapest methods of regeneration.



*The Field of Wood Utilization Benefits From Research*

Let me give you an example of adapting fundamental knowledge to the field of wood preservation. Basic research, in wood preservation, on relationships between the chemical constitution of benzene derivatives and their toxicity toward wood-destroying fungi led to the discovery of a relationship between the molecular weight of chlorinated compounds and their toxicity. As a result, industry was informed that chlorination appeared to be an effective means of increasing the toxicity of certain benzene derivatives, and that the more highly chlorinated phenols should be highly toxic and have other properties making them suitable for use as wood preservatives. The attention of a manufacturer of chlorinated compounds was directed to this finding, and he supplied the Forest Products Laboratory with sufficient tetrachlorophenol to check the laboratory findings, and subsequently also some of the still more highly chlorinated pentachlorophenol. Evaluations of these products confirmed their high toxicity toward decay fungi.

The first commercial use of pentachlorophenol was as a control for sap stain in the dip treatment of lumber. It was soon found that a dip treatment of wood in solutions of pentachlorophenol in light petroleum carriers leaves wood paintable and relatively odor-free — two advantages long sought in a preservative not leachable from wood by moisture.

Industrial use of pentachlorophenol dissolved in heavy oils for pressure treatment of poles, posts, piling, and other wood items, in the manner in which creosote has been used, is in wide application today.

The double-diffusion preservative treatment, in which the two chemicals diffuse into the wet wood and then react together precipitating a compound that is poisonous to termites and to fungi that cause decay, is in wide use today, with a plant in Virginia using it. The compound formed in the wood is practically insoluble in water and, therefore, does not leach to any great extent from the wood when it is used in moist soil.

Fundamental research on the chemical fractionation of wood, by the Forest Products Laboratory, has yielded a procedure for separating out the entire carbohydrate fraction that has proven of inestimable value to paper-makers. This research, leading to the new "holocellulose" or pure cellulose extraction method, has not only finally given the paper industry a firm standard for evaluating various pulping processes, but has resulted in much-improved methods for obtaining highly purified cellulose — so-called  $\alpha$  cellulose—from wood for use in textiles, plastics, and explosives.

While even our most earnest supporters have not tended to regard forestry as a very sophisticated science, I believe that the few examples I

have given you of today's forest research that is of direct concern to Virginia and to other States, may convey the complexity of solving our problems. I have also tried to show the part that digging deeper and deeper by highly-trained specialists, using modern facilities and methodology, is playing in converting forest management from what was largely an art based on rules of thumb, to a science based on established facts. This deeper probing is also telling us why things happen — not just that they happen. When we know why they happen, results can be duplicated and this takes out the guess-work and leads to dependability of treatments and economy in our forest practices and in the utilization of wood.

This State of Virginia, with two-thirds of its land in forest must use this resource wisely. The necessary wisdom will come in part from experience and in part from experiment. While experience will mold, adapt, and refine the knowledge we have, it will be largely through fundamental research that new approaches to our problems, that would scarcely ever be conceived of by the general practitioner, will come.

## GROUND WATER SUPPLIES AND GEOLOGIC RESEARCH

DR. JOHN C. FRYE, *Chief, Illinois Geological Survey, Urbana, Illinois*  
*Introduction*

Food, air and water are universally essential materials to all mankind. Food may be of many kinds and varieties, but if man's water supply deviates as much as a few tenths of a percent from purity it becomes unusable. Adequate sources of good or usable quality water have been available to all groups of civilized men throughout recorded history. When population pressures rendered the local water supply inadequate the populace either imported water from a nearby source, or moved themselves to the more abundant supply. Man has generally regarded water, like the air he breathes, as so commonly available that its continuing adequate supply was not a matter of serious concern.

For the most part, the world's population lives in relatively well-watered areas and it would indeed be untrue to imply that there is a net shortage of potable water. At present, there is without doubt an abundance of water. For example, it is estimated (MacKichan and Kammerer, 1961) that in 1960 the withdrawal use of water in the United States amounted to 270,000 million gallons per day, or about 1,500 gallons per day per capita. There are, however, two factors in addition to the increase in total world population that prompt us to take a careful look at our future water supplies: First, the increasing concentration of people in metropolitan areas, and Second, the increasing rate of water use on a per capita basis (U.S. Bur. Census, 1959). These factors have already produced shortages of water in some areas. Even though we may contend that local shortages are only the result of a lack of distribution facilities and can be solved at a price, they have a profound effect on the future growth and economic development of the areas involved.

The trends of water use, and some projections into the future, have been illustrated by Dr. G. B. Maxey of the Desert Research Institute of the University of Nevada. Water use curve is trending upward more sharply than is the population growth curve for the United States. In viewing the trend in per capita use of water and the trends of the major categories of water use, it is interesting to note that uses for electric power generation and by industries are expanding at a more rapid rate than is the use by public water supply systems.

The water supply available to any area is the total quantity of potable



water that can be obtained, year after year, from all sources. Part of this water flows across the surface and can be captured for use from streams, lakes or artificial impoundments. Surface water originates from precipitation that runs off the surface to streams, plus some that has penetrated the rocks and has subsequently returned to the surface; it is disposed of by consumptive use, by flowing out of the region and eventually reaching the ocean, by evaporation, and by transpiration of plants. There are many complexities in evaluating and utilizing surface water supplies, but, perhaps because surface water can be seen there is a general awareness of many of these problems.

Virginia is fortunate that it contains many areas well supplied with surface water of good quality. I have read with much interest the excellent brochure, "Water Resources of Virginia," published in 1959 by your State Soil Conservation Committee, and several of the reports of your State Geological Survey. I will not take time to summarize what is already known, except to say that Virginia enjoys a favorable situation in water — one that should be preserved and improved by research and planning.

Water draining off of 75 percent of the State's land area produces an average daily flow amounting to 20 billion gallons. If only half this discharge were utilized for domestic use, Virginia could easily supply more than 10 times its present population with water at the rate of 300 gallons per person per day. I would hope that Virginia is not being complacent about investigating its water resources. The fact that it has such abundant water resources — outstanding in general quality as well as in abundance — puts all the more responsibility on the State to develop a body of specific data on its water resources and keep it up to date.

I shall confine my further remarks to the less well understood and evaluated ground water, and its intimate relation to the rocks that contain it and through which it moves.

Beneath the surface of most regions a large quantity of water is contained in the pores and fractures of the rocks, and, although this ground water is moving slowly, in most regions it vastly exceeds the quantity of water that can be observed and measured at any one time on the surface.

The origin of ground water has been attributed to several sources. It has been demonstrated that some water may condense from molten rocks deep below the surface and such water has been called juvenile or "new" water. Also, some water may be trapped in the pores of sedimentary rocks that were deposited in oceans, lakes or rivers; this water is called connate water. However, juvenile and connate waters are insignificant in quantity, and generally they also are poor in quality, and therefore, from the practical standpoint of water supply for human use we need con-



sider only infiltrating rainfall and surface water as the essential source of ground water (Meinzer, 1942). This is generally called meteoric water.

As I mentioned, some water from the ground enters streams and flows away from the region and now we see that the primary source of water in the ground is from precipitation on the surface. These are the important elements in the "hydrologic cycle." Water falling on the surface in part runs off, in part evaporates, and in part penetrates below the surface of the soil. Of the water that penetrates below the surface, part is captured by plants and returned to the atmosphere by transpiration, part is temporarily retained in the soil, and part moves downward from the soil until it reaches a zone in the rocks where all the pore space is filled with water. This point is called the water table, or the top of the zone of saturation. Obviously, at this point direct downward movement is no longer possible but lateral movement may take place. If there is inflow of water, or recharge to the saturated zone, there must also be outflow of water, or discharge. This discharge takes place down the water table, or pressure slope, into a stream or body of water. Thus, the cycle is completed by the ultimate return of the water to the ocean or the atmosphere. Quantitatively it might appear that these factors should all be subject to accurate measurement. Indeed, this would be the case if all rocks were uniform and homogeneous, and if precipitation, evaporation and transpiration rates were constant. Since the opposite is true with regard to both the geology and the climate the problems of evaluating ground-water supplies are extremely complex.

Even though we are not dealing with climate, a general observation concerning its role in ground-water supply is necessary. Since the source of usable ground-water is largely from precipitation in or relatively near the region where it is used, the quantity of precipitation determines the maximum limit of the perennial ground-water supply. However, that part of the rainfall that eventually penetrates to the zone of saturated rocks and becomes available for use ranges within wide limits, and therefore it is unfortunately true that a high rate of rainfall does not assure large ground water resources. At the extremes the percent of the total rainfall that recharges the ground-water reservoirs may be as low as zero or a small fraction of 1 percent, while in particularly favorable spots it may approach 50 percent or more. The rates of evaporation and transpiration are factors that exert an influence on this rate, but by far the most important factor is the geology and topography of the region.

In view of the progressively increasing demand for water for human use, a realistic approach in planning is to consider water as no longer free for taking, but a commodity essential to human welfare that must be secured, managed, and distributed at a cost that is economically tolerable.

An indication of what these costs may be in the future is indicated by the U. S. Department of Commerce prediction that about \$171 billion will have been invested in water projects by 1975.

Now let us take a look at some of the present and future research needs in ground-water geology.

Ground-water geology is a relatively new branch of the science, probably because the former abundance of water has not caused us to focus attention on these problems until recent years. Furthermore, the kinds of questions that must be answered by the ground-water geologist have drastically changed during the past two decades. During the first third of the present century, when Dr. O. E. Meinzer and his associates in the United States Geological Survey were doing their pioneering ground-water work, the major questions asked of the geologist were where and how deep is water-saturated rock of sufficient permeability for the development of a well. This called for ground water exploration. Although in some areas questions of continuing yield, ultimate maximum quantity available, rate and area of recharge, and even the possibility of artificial recharge were being considered, by and large the major problem for the geologist was the location of a source for a well supply. I do not mean to minimize the importance of this function or to suggest that this type of work is no longer needed. The knowledge that a good well can be obtained by drilling an additional hundred feet, or that a supply is available in an area where previously it was not known to occur, is indeed important. To answer such questions requires a sound understanding of the regional geology and the basic principles of ground-water hydrology. However, many questions have now become more complex and include, for example — "What is the maximum quantity of water that can be developed on a continuing basis in a metropolitan area?" — "What will be the effect on recharge and thus on ultimate water supply of a 20-foot lowering of the water table by pumpage?" . . . "What is the rate and distance of movement of pollutants through a particular sandstone, and will these factors be markedly different in fractured crystalline rocks or cavernous limestone?" . . . "How can we safely dispose underground of liquid atomic wastes?" . . . "What is the predicted rate of salt water encroachment in a coastal area?" . . . "How can we plan for conjunctive use of ground and surface water to produce the most reliable and economic supply?"

These and other questions now being posed to the ground-water geologist call for a degree of detailed knowledge of the rocks and their composition and configuration that was unthought of just a few decades ago. They also point up the necessity of close collaboration among the geologist, hydrologist, geochemist, and geophysicist.

One example will serve to illustrate the interdependence of geologic and

hydrologic data when the answers required are quantitative and long range. In the evaluation of ground water supplies available for the village of Arcola, Illinois, the State Geological Survey developed the geological data and the engineering analysis was made by the State Water Survey (Walton and Walker, 1961). The water supply problem occurred entirely within the Pleistocene deposits overlying the bedrock and these deposits consisted of glacial till and outwash of silt, sand and gravel. As the outwash deposits, which constituted the aquifer consisted largely of the fill in a relatively small bedrock valley it was possible to develop a rather simple and straight forward geologic setting for the hydrologic analysis.

In addition to the geological data the engineer needed data from pumping tests to determine transmissivity and coefficients of permeability. Long term data were obtained from the records of withdrawals from the existing municipal wells and observation well measurements supplied records of water level declines or fluctuations. From these data it was possible for the engineers (Walton and Walker, 1961, p. 3362), by use of the image-well theory and the steady-state leaky artesian formula, to construct a mathematical model that could be handled by a digital computer (Walton and Neil, 1961). This mathematical model was used to predict the point in time when the increasing pumping demands of the village of Arcola would exceed the practical sustained yield of the existing well field. In other words, the known past history of the well field is explained mathematically and by an independent method its future is predicted.

This same general approach has been used on much more complex situations involving much larger areas, as is illustrated by the recent report on the group-water resources of the Chicago region (Suter *et al.*, 1959). In this study the availability of both geologic and engineering data varied from aquifer to aquifer and as a result more definitive quantitative answers were possible for some parts of the ground-water system than for others. Currently cooperative studies are under way to produce quantitative data for the entire ground-water complex.

It is clear that, as the tools and methods of quantitative analysis are refined and improved, the demand is progressively increasing for more refined and detailed knowledge of the character, configuration, lateral variation, and mineralogy of the rocks that transmit, confine, and yield the water. For that reason I will devote the remainder of my remarks to the basic geologic research that is needed for application to problems of ground water. Although this will include a wide range of geologic situations most of them are applicable to Virginia. Virginia includes an area of the Coastal Plain with its weakly consolidated Cenozoic rocks in gently dipping strata; a segment of the Piedmont and Blue Ridge provinces underlain by well indurated, complex, crystalline rocks; a belt of folded Paleozoic rocks; and even some areas of relatively flat lying Paleozoic rocks. Cross



ing all of these geologic provinces are alluviated valleys with their particular set of ground-water problems. Within the state there is a wide range of geologic environments controlling the occurrence of ground water.

Perhaps the most universally needed phase of basic research in ground-water studies is in the field of stratigraphy, which, paradoxically, is perhaps the oldest subdivision of the science of Geology. For more than a hundred years it has been the objective of the stratigrapher to correlate and trace the various strata or rock layers within the sedimentary sequence. He has been concerned with establishing the age relationships from place to place so that the history of the earth's crust could be determined. From these correlations the gross structure of the rocks can be deciphered. Such work has indeed been successful and has had great practical value in the search for water, oil, and other minerals. However, we now must know in detail the lateral changes in the physical character of each stratum of rock as these changes affect all of its hydrologic properties. This approach has been called litho-facies stratigraphy and is concerned with the determination of lateral changes in permeability as well as thickening, thinning and mineralogical changes.

If I may be permitted to draw another example from Illinois, the cooperative work by the State Geological and Water Surveys in the Chicago region well illustrates the importance to ground-water evaluation of litho-facies studies. The preliminary study of the region (Suter, *et al.*, 1959), although yielding many answers, left the quantitative answers to other questions either indefinite or questionable. It is necessary for the geologist to produce more precise data on the hydro stratigraphic units in the deep Cambrian and Ordovician rocks, and even more urgent that such data be produced for the Silurian dolomites at intermediate depth and the Pleistocene deposits at shallow depth. To fill this need of the hydrologist for precise data as a basis for quantitative analysis, we have for several years been studying the lithologic variations of the many stratigraphic units involved.

The same region may be used to illustrate a closely related line of basic research in subsurface geology, namely paleo-geomorphology. When rocks are exposed at the surface of a land area for a significant period of time ground-water circulation is established, and, if the rocks below the surface contain a large percentage of limestones and dolomites, the circulating meteoric waters differentially and strongly modify the permeability of the rocks through which they circulate. Such modification of rocks below a former topographic surface produces a special kind of litho-facies unrelated to the original deposition of the rocks. When such a landscape is buried by younger deposits many of these acquired characteristics are preserved and may have an important influence on the movement and available



quantity of ground water at depth. The topography of the buried surface also importantly controls the volumetric relationship of the rocks first deposited over the ancient land surface (Buschbach, 1961).

Reconstruction of the features of a landscape now hundreds or even thousands of feet below the surface is a difficult task indeed. Where many wells have been drilled to below the old surface, as is true in some parts of the mid-continent region, a reconstruction can be made with some assurance, but in regions where drilling has been sparse it is necessary to postulate by analogy with present landscapes. Recently, geophysical methods involving not only electrical resistivity and seismic methods but also gravity measurements have been used successfully for determination of deeply buried topographic features.

In buried limestone and dolomite terrain, particularly, a "feedback" to the geologist from hydrologic data may be quite effective. Unexplained local changes in permeability and transmissibility may be just the clues needed to aid the geologist in the reconstruction of the conditions below the ancient buried land surface.

Closely related to the modern approach to litho-facies stratigraphy are the problems of determining and predicting the physical differences among the several kinds of rock permeability. In general, permeability in rocks may be produced by the openings occurring among the grains in a clastic sediment, sometimes partly filled by secondarily deposited cement; by fractures, joints or brecciation in otherwise relatively impermeable crystalline rocks; and by openings or solution channels in the carbonate rocks and in gypsum-anhydrite made by the solvent action of water moving through them. In the case of uniform clastic sediments laboratory size samples can be analyzed and a reasonably good evaluation of the permeability made. However, the fracture, joint, and brecciation permeabilities, as well as those produced by solution, are gross, and a truly representative sample cannot be analyzed in the laboratory. In these cases the structural history of the region and the post-depositional history of the individual rock units must be considered together with regional hydrologic data in order to arrive at an approximate value for transmissivity, water storage, and ultimate yield. For example, such minutia as a percent or two of change in the chemical composition of a limestone may control the location and size of the solution openings that will develop.

The chemical and mineral compositions of rocks through which water moves also exert an important control on the quality of the water, and are particularly important in problems involving the mobility of pollutants and contaminants. Not long ago the clay mineral content of a water-bearing bed was viewed as just another detriment to the flow of water. Now there are cases where these clay minerals may be viewed as ion

exchangers that modify the dissolved constituents of the water, and they may be a mechanism for removing harmful materials including radioactive isotopes. Other chemical problems have been brought to the fore by the increasing widespread use of detergents and their apparent great distance of travel through permeable rocks.

Although we have touched upon several problems of basic geologic research essential to improved analysis of ground-water supplies, we have by no means exhausted the subject. We have not discussed the problems of multiple use being faced in some metropolitan areas, the problems of conjunctive use of surface and ground water that are present day realities in arid and semi-arid regions, or the problems of salt water encroachment, oil field brine disposal, or disposal of radioactive wastes. Perhaps most basic of all we have not discussed the mechanics of water movement through the soil and unsaturated zone of rocks in the recharging of a ground-water reservoir.

The relatively rapid change from the primary need for exploration for and location of ground-water sources to the expanded need for precise quantitative answers to the questions of "how much," "how long," "what quality," and "where to," has placed greatly increased demands on the ground-water geologist, or hydrogeologist if you prefer the recently coined term. These expanded needs are also felt by the public agencies, such as the United States Geological Survey and the one or more state agencies in each state that have responsibility for evaluating present and future water resources. I hope these few examples have served to illustrate this change in demands, that now and in the future, will be placed on the geologist.

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## LIVING MARINE RESOURCES

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*Introduction*

I am pleased to see that the final paper in this symposium deals with people. Too often it is forgotten that people, too, are a natural resource. Even more significant to the marine scientist, however, is the fact that our interest in natural resources, and our support of research on them, exist because these resources are useful in some way to people. This utility may be aesthetic, or it may be practical in the sense that someone may make a profit from it. Whatever the reasons, people and natural resources are inextricably entangled one with the other. We cannot study the resources intelligently without considering their utilization by people, nor can we do so without considering the effects of people upon the resource.

People, with their different social and educational backgrounds, their varying points of view, and their diverse economic and aesthetic interests, generate controversy. This is an essential part of our democratic way of life. At least four groups, each with unique backgrounds and interests, are involved in the controversies that concern Virginia's living marine resources. Commercial fishermen depend on these resources for most, if not all, of their livelihood. A growing body of saltwater sport fishermen gain healthful recreation from their hobby. The State Legislature makes the laws on which conservation of these resources is based, and tries to view fishery problems broadly in relation to other important uses of Chesapeake Bay and its estuaries. Public administrators, including scientists of the State and Federal Governments, have a duty to interpret and enforce the laws, make continuing surveys of the condition of the fishery resources, and develop a body of scientific knowledge from which wiser laws and more intelligent management can be based.

It is sometimes surprising, in view of the widespread disagreement on causes and cures of fishery problems of this region, that the basic truth is not more clearly recognized. It takes little effort to recognize that disagreement must signify inadequate knowledge. If we had the facts, and their meanings were analyzed clearly and properly disseminated, general agreement on the fundamental principles of conservation would follow. As it is, the need for greater understanding has been recognized and is growing, as demonstrated by the growing support of scientific research in both States that border the Chesapeake. But there is strong disagreement in segments of all interested groups as to the values and pertinence



of scientific findings to date. Indeed, it must be admitted that the scientists, themselves, have not always agreed on interpretation of their own data. When the facts are incomplete, there is always room for honest disagreement. The public should not be disillusioned when scientists fail to agree, nor should scientists become too discouraged when non-scientists disagree with them. Instead, all should rise to the challenge and plan for a gradual convergence of understanding.

Some of my academic colleagues tend to look down upon those of us who study fishery resources. They view our inevitable association with commercial fishery interests, sport fishermen, and lawmakers as a form of scientific prostitution. On occasion, they have been known to refer to us somewhat contemptuously as "politicians." I would suggest that those few who have adopted this attitude have failed to look deeply enough into our particular mission as marine scientists. People are an integral part of the environment we are studying.

I prefer to consider that the science of the living resource of the sea is the very broadest kind of ecology. As such, it includes the meteorological sciences, the physics and chemistry of the waters, the biology of the animals and plants of the sea, and of some freshwater, terrestrial, and aerial organisms as well. It extends to the geology of ocean shores and bottom, the engineering aspects of instrument design and function, the design of ships for scientific research and fishing, and the development of new and more efficient types of fishing gear. Finally, it concerns the interactions of all these forces one with the other, to produce the dynamic entity that we call the oceans.

It is important also to recognize the roles that man plays in the ecology of the sea. It is recognized widely that he influences the abundance of marine animals directly, by fishing, by killing organisms he regards as pests, or by protecting those he considers desirable. It is recognized also that he influences abundance indirectly, by polluting the waters, building bridges, dams, breakwaters, and other permanent structures, or filling marshland, dredging channels, and otherwise changing the biota and the topography. It is much less widely recognized that he exerts more subtle influences upon the economy of the sea by his peculiar ways of doing things or his peculiar habits of thinking. Thus, economics and social-political forces are important elements in fishery ecology, and these subjects deserve far greater attention than they now receive. I would say that the effects of man's activities are more often misinterpreted than judged correctly. When they are invoked for purposes of "conservation," as when fishery laws are formulated and enacted, more often than not the effects are quite different from what was intended. In the United States particularly, where fishery laws and enforcement are the prerogative of the individual States, some ridiculously provincial ideas and traditions hold

sway. In many States the fishery laws contribute to the sad economic state of the fisheries by making it impossible to harvest these resources economically. Thus, the study of mutual relationships among marine organisms and between them and their environment must extend beyond the boundaries of the ocean to include all the interrelationships with men. This is ecology in its very broadest sense, the only sense that will lead to full understanding of fishery dynamics.

### *Basic and Applied Research*

In view of the title of this Symposium, some remarks about the definitions of basic and applied research are appropriate. Previous speakers have pointed out that these two kinds of research are difficult to separate, and that such separation is not necessarily important. I agree with this view. Nevertheless, these terms are in wide use today, and it might be well to consider how the two categories might be applied to the living resources of the sea. Several dichotomies might be selected, each of which would be unsatisfactory to some. One such division might be that applied research is research on individual species of particular interest more or less to the exclusion of their competitors, predators, or their environment in general. This classification would characterize basic research as the broad study of the species in relation to its environment. Many times in the past, government appropriations for fishery research have been restricted by law to the narrow concept represented by the first of these two definitions, and our knowledge has suffered thereby. It might be considered that these two concepts represent natural stages in the evolution of the science of fishery research. Fortunately, we now are moving rapidly toward the "sophisticated" view represented by the ecological approach. I prefer, however, to consider that all significant research is prompted by man's desire to know more about the world around him, and that any division of such research into basic or applied categories is quite artificial.

### *Virginia's Marine Resources*

Let us look at a few important marine fishery resources of Chesapeake Bay, examine their history, their present condition, and their future prospects. I have chosen three, which I think are particularly appropriate for my purpose, one a mollusk, one a crustacean, and one a fish. These three account for about 75 percent of the total value of Chesapeake commercial fishery landings, and they are representative of the diversity in kinds of animals and types of life history that characterize the marine resources of this region. In selecting these examples I have omitted the growing salt-water sport fisheries of the region, which take large number of food fishes of a variety of species, some also of commercial importance. I have done this not because the sport fisheries are unimportant, for they provide recrea-

tion for a great many people, and constitute a major commercial enterprise as well. But time will not allow adequate treatment of all fishery resources, and the sport fisheries alone could easily occupy the entire period allotted to me.

### *The Oyster Resource*

The oyster, of course, is the principal fishery product of Chesapeake Bay. The annual harvest is worth more than the total harvest of all other fishery resources combined. Except for a brief period after spawning, when the young are free-swimming, oysters are unable to move from the place where they first attached themselves to the bottom. For this and other reasons they are readily cultivated, and their numbers are controllable by man.

The naturally-producing oyster grounds in Chesapeake Bay are for the most part in waters of intermediate salinity. This is because oysters are able to tolerate fresher waters than their principal enemies and diseases, and because they are better protected from the effects of storms. Oysters however, cannot tolerate fresh water for any great length of time. Thus, in Virginia the natural grounds are principally fairly well up the estuaries, but in Maryland, they are nearer the mouths of the estuaries or in the Bay, itself.

Seventy years ago oysters dominated Chesapeake Bay fishery landings. About 22 million bushels were produced in 1890. At today's prices these would bring to oystermen more than \$77,000,000 for their catch. But landings in both States have declined rather steadily since the end of the 19th century, and in 1961 the total harvest was less than 6 million bushels, worth about \$19,000,000.

The belief is quite generally held that the naturally-producing oyster grounds belong to the citizens of the States. Thus, Maryland and Virginia both have set these grounds aside as public grounds, and have enacted laws that regulate the taking of oysters. Both States also devote considerable effort to rehabilitation activities, planting shell back on the grounds to serve as clutch for the new crop. In other respects, however, the two States differ sharply in their oystering policies. Virginians believe that the oyster industry thrives best under a system of farming, and the State has a liberal policy of leasing barren bottom in the estuaries and in the Bay. Oyster planters improve this bottom, when necessary, by planting shell or otherwise preparing it for seeding. The State permits tongers to take young oysters from certain public grounds for planting on these otherwise barren grounds. Planters lease these grounds, at a nominal fee, from the State.

In Maryland, on the other hand, public policy generally has been opposed



to private planting. Proponents of private enterprise have prevailed at times, and a small acreage of bottom is under lease, but this is quite small in relation to the extensive area designated as public ground. The State spends rather large sums annually to plant shell on the public grounds, and also transplants oysters from one area to another.

How effective are these policies? More than 85 percent of Maryland's production is a wild crop, harvested from public grounds. Three-quarters of Virginia's production, on the other hand, is grown on private bottom. Virginians point with pride to the success of their more liberal policies, which have maintained fairly steady annual harvests for the past 40 years. Marylanders believe that their accelerated program of public management will halt the decline and will, in the long run, demonstrate its superiority over private enterprise. The facts seem to favor Virginia's view over Maryland's but it cannot be denied that that production has fallen substantially in both States. Obviously, something is wrong. Moreover, although State policies diverge sharply, opinion is by no means unanimous within and between factions. These battles are a conglomeration of lack of knowledge, prejudice, conflicting interests, and inefficient harvesting and management practices. It is only necessary to consider the Potomac River, where an estimated 42 square miles of oyster dredging grounds in the 1890's were reduced to about 11 square miles by 1942, or the Rappahannock and other estuaries in Virginia, where many formerly productive natural grounds now are barren, to realize that the fishery was removing more from these bottoms each year than nature was able to replace. Within the confines of your own city lies the body of water known as Lynnhaven Inlet, once known widely as a source of prime quality oysters. These famous Lynnhaven oysters came from naturally-producing grounds long since denuded, and this historic name now is but a memory to oyster lovers.

### *The Blue Crab Resource*

The blue crab fishery has generated just about as much controversy in the Chesapeake Bay States as the oyster fishery, although the basic problems and the facts are not at all similar. In contrast to oysters, which are essentially sedentary animals, blue crabs perform extensive annual migrations, although it is believed that these migrations do not extend to any great degree beyond Chesapeake Bay. In late summer and fall, having been fertilized already, adult female crabs begin to migrate down the estuaries and down the Bay toward the deeper, saltier waters in Virginia near the Bay entrance. Here they spend the winter, more or less dormant, carrying the mass of developing eggs, or "sponge," attached to rudimentary legs beneath the abdomen. The young hatch the following spring and summer, and spend several weeks as feebly-swimming, drifting larvae, more or less at the mercy of tides and currents. Because the deeper, saltier

water moves slowly up-Bay and up the estuaries, the young crabs begin their first winter of life farther up the Bay and estuaries, and they resume this migration in spring as the water warms. By mid- and late summer, at an age of one year to a year and a half, they become adults, spawn, and the fertilized females begin their return migration. It is believed that few, if any, survive beyond three years.

The fishery uses a variety of gears and operates throughout the year in one area or another. The catch and the abundance of crabs fluctuates widely, but there has been no solid evidence that the yield is declining, despite the gloomy views that have been expressed from time to time. Nevertheless, the wide fluctuations create serious economic problems in the industry, and opinion is not unanimous as to the cause. A divergence of opinion exists similar to that surrounding oyster problems, and there are strong agreements and disagreements within and between States.

One rather common prejudice is a belief that it is harmful to catch crabs bearing eggs. Both States have enacted laws to prohibit capture of "sponge" crabs, and Virginia maintains a large sanctuary in the lower part of the Bay where pregnant females congregate in winter. In general, however, Virginia's crab laws are more liberal than Maryland's and Virginia has fewer gear restrictions and closed seasons. For these reasons, Marylanders are prone to blame the Virginia fishery when crabs are in short supply. But the scientific evidence leaves little doubt that environmental effects upon the success of blue crab spawning are more powerful than the fishery in determining abundance and future catches.

### *The Menhaden Resource*

In terms of weight landed, menhaden support the largest fishery in Chesapeake Bay. Spawning takes place in late fall in the ocean, but the young soon enter the Bay and penetrate the estuaries into waters of low salinity. Here they spend the winter. In spring they begin to grow rapidly, moving slowly down the estuaries and the Bay. By fall, at one year of age, they are 5 to 6 inches long, and migrate to the ocean to winter farther south. Each year thereafter they make a northward migration in spring and summer and return to southern waters for the winter. In each successive year of life this migration extends farther north.

Menhaden are filter feeders, straining microscopic plankton from the water through their finely-spaced gill rakers. They occur in great abundance in Chesapeake Bay in summer, and they harvest great quantities of plankton. One of the airplane pilots whose job it is to spot menhaden schools for the seine boats once told me that often the murky waters of the Bay are miraculously clear immediately behind a menhaden school. This led me to wonder what the total plankton consumption of these abun-

dant fish might be. In the absence of better knowledge I had to make some assumptions. These were that a single menhaden strains a column of water one inch in diameter at a rate of one knot, and that the population of menhaden present in Chesapeake Bay is double the annual catch. These may be conservative assumptions, as I assumed, or they may be quite unrealistic, as the surprising result suggests. On this basis I came to the conclusion that the summer population of menhaden in the Bay could filter all the water in the Virginia portion of Chesapeake Bay and its tidal estuaries twice in 24 hours!

### *Ecological Implications*

Menhaden also serve as food for the larger carnivorous fishes in the Bay. We know that striped bass and bluefish eat large numbers of menhaden at certain times. This has caused some people to think that menhaden purse-seining is harmful in two ways — it competes with food and sport fishes for food, and it catches these desirable species along with the menhaden. These are two principal reasons why Maryland does not permit menhaden purse-seining.

These interrelationships are interesting and important, and we know far too little about them. Opinions play a large part in framing fishery laws, and this is a good example of the effect of foggy thinking upon fishery resources. Menhaden fishing is denounced vigorously at times because it is believed to affect the abundance of food fishes. But no one ever has suggested that menhaden should be eliminated because they eat large quantities of plankton. Yet blue crabs and oysters spend part of their early life as plankton organisms, where they are vulnerable to just such predation. Menhaden usually are most abundant in the Bay at exactly the times and places occupied by the newly-hatched blue crab larvae. It is possible that this could be a most important factor in determining blue crab abundance. Investigation of this interrelationship would be an exciting piece of basic research, which would tax the imagination of the most competent scientists. The problem has many ramifications, including the need to understand distribution in time and space, food habits, and the relation of these animals and their associates to their physical and chemical environment. I am sure that these relationships would turn out to be most complex, and that a simple inverse correlation between abundance of menhaden and blue crabs would not be found. Menhaden are typically unpredictable in their movements. Their food requirements, as calculated above, if this example is at all realistic, suggest why this is so. If they did not move about continuously and over a wide area, they might very well deplete their food supply.



*Man-made Environmental Changes*

As our population grows, and our industrial development becomes more complex, the characteristics of our marine environment are certain to change in many ways. Domestic and industrial wastes introduce a variety of new substances into the waters, some toxic, some oxygen-consuming, some perhaps beneficial. These substances begin to change as soon as they are introduced — some are oxidized, some broken down by bacteria into simpler substances. But they also exert their own influences upon the marine environment, and cause changes in numbers and relative abundance of the different kinds of animals and plants. The gross changes, which sometimes cause spectacular mortalities, are easy to see and understand. But there are other, more subtle changes that we still know little about. For example, what effects do such wastes have upon the spawning of oysters, development and setting of their larvae, and their feeding, growth, and other metabolic activities at all stages of development? Experience in the western end of Lake Erie, a more or less self-contained body of water partly separated from the rest of the Lake by a chain of islands illustrates what can occur. Growing domestic and industrial pollution from the heavily industrialized area to the north, pouring into the Lake from the Detroit River, has caused spectacular changes. Water temperatures have risen appreciably, the dissolved oxygen content has dropped, and the animal population has changed in response. Insect larvae, such as those of mayflies, formerly abundant on the bottom, now have virtually disappeared. In their place have come great increases in numbers of pollution-loving forms, such as worms. It will be a long time before such dramatic changes take place in Chesapeake Bay, but some of our waters near sources of pollution are in as bad or worse condition already. But it is the smaller changes that occur in response to incipient pollution that are most difficult to detect and understand.

*Costs of Research*

Research in the marine environment is costly, and the costs have not been easy to justify. On what basis should we decide what amounts are justifiable as an investment in research on living marine resources? This problem is constantly before the research director of your State Marine Laboratory as he plans his requests for funds to present to the State legislature. The problem is constantly before appropriations committees and the executive heads of government as they try to fit increasing budget requests from a variety of worthy government agencies into a fixed estimate of revenues. Total requests are always larger than estimated revenues, and cuts necessarily must be made. If it is decided that research on the marine resources should be increased, the increase must be at the expense of some other agencies. It would be extremely useful to the

budget planner if he had an objective estimate of the amount he could reasonably expect to receive.

One such estimate might be based on the value of the resource. The annual value of Virginia's commercial fish catch, as paid to fishermen at the point of landing, is about \$20,000,000. If 5 percent is a reasonable proportion of the value of the catch to be invested in research, then the annual budget should be about \$1,000,000. If the research budget should be determined on the basis of retail value, then this figure should be about \$2,500,000. To this might be added an amount based on an estimate of the value of the saltwater sportfishery. No one yet has developed a satisfactory method of comparing the value of a commercial and a sport fishery.

Other considerations must enter into such estimates if they are to be realistic. If it is decided that a certain percentage of the value of the resource can be used to set the level of the research budget, should the costs of management of the fishery and enforcement of laws be charged against this fund? Should the value of the fishery be based on present landings, or should potential landings of latent resources be included? If certain species have been overfished, and present landings are well below the maximum sustainable yield of the resource under scientific management, should the budget be based on the present or the potential yield? Should the estimate of optimum research budget take into account the amounts being spent by Federal or other laboratories on the resources in question? These are but a few of the questions that need to be answered if budget levels are to be estimated and justified on such grounds.

Another method of estimating budgetary levels might be based on the argument that for each research objective there is a certain budgetary threshold, below which there is little likelihood that the objective could be achieved. If this threshold could be determined, then the annual budget might be decided in terms of the need for information. The time required to reach the objective would be related inversely to the size of the budget.

At present these matters are quite speculative, and budget levels are determined much less objectively. The principal factors are public support, energetic research leadership, and available revenues. A detailed study of this question might be a valuable part of long-range research planning.

### *General Conclusions*

The root of fishery problems is people. Selfish interests and narrow views, imposed on a complex situation involving economic as well as biological variables, are important elements. Pressures caused by growing

industrialization and increasing human population threaten to outstrip our slowly accumulating stock of basic knowledge. A broad field of inquiry must be pursued if we are to use our marine resources wisely. It would be naive to assume, of course, that with sufficient knowledge and enlightened public policy all these problems would disappear. Many elements in this complex are mutually antagonistic and always will be. Our aim should be to achieve the best possible combination of circumstances that will serve all human interests. This seems an almost overwhelming task, and the perfect solution never will be found. It follows that controversy always will be an important by-product. Indeed, although our knowledge will increase more rapidly as our support of research on living marine resources grows, public controversy may well increase also as our expanding human population comes into ever more intimate contact with the problems its very growth will generate.

One important deficiency is in the field of public education. Our knowledge of the biological, physical, economic, and social — political aspects of fishery management is far better than many people realize. We are not taking full advantage of our opportunities to improve public knowledge and understanding. For example: we should be putting far more effort into helping the industry to apply our present scientific knowledge of oyster biology. We should establish a shellfish extension service similar to the agriculture extension services on which our highly successful agricultural industry is based.

When we add the effects of pollution and the other by-products of industrialization and human population growth to the other problems of the oyster industry, it becomes clear that some highly-controlled form of farming is inevitable if the oyster industry is to survive in areas close to civilization. Yet we are still conducting much of our research and management as if virgin conditions will be with us forever. Scientists believe that the time has come to apply accumulated knowledge to develop a higher level of oyster culture.

At our present level of knowledge, little can be done to reduce fluctuations in crab or menhaden abundance. But there is hope that we can apply our knowledge to a system of forecasting, which would allow the industry to plan ahead.

The individual fisherman, with limited capital, is in a very poor position to withstand fluctuations in abundance of wild stocks, even if he should have advance information. The traditionally independent attitude of Chesapeake Bay watermen may not be in their best economic interest. The opinion is given, when a system based entirely on private enterprise is advocated, that this soon would result in control by a few. Undoubtedly this is true, but the individual might be better off financially working for



a large fishing company which had sufficient working capital and diversification of operations to hedge its losses. Obviously, these watermen place great value on their independence, placing it above mere economic gain. In our rapidly changing world, this is unfortunate, for a system of private enterprise seems inevitable if our inshore fisheries are to survive. Recognition of this fact now would allow an orderly revision of the structure of fishing operations. This illustrates the importance of considering social and political, as well as economic matters, in applying the results of research to fishery management.

We do not have a very clear idea as to how much should be invested annually in research on our living marine resources. It is generally agreed that present research effort is inadequate. As a part of long-range program planning we should attempt to develop objective criteria for determining budget levels.

## THE HUMAN RESOURCES

DR. CLARENCE C. LITTLE

*Scientific Director, Tobacco Industry Research Committee, New York City*

During this symposium we have heard a most interesting discussion of the natural resources of Virginia. Their great diversity, extent and possibilities for development have been clearly demonstrated. They present challenging and stimulating opportunities for the continuation of a rich and satisfying physical environment for future generations of Virginians to enjoy and to care for.

My task is to discuss these Virginians, the human resources — those of you who are here today, those other citizens not here, and the children, grandchildren and even more remote descendants of all of you.

Obviously, this is far more than a “one-man” job, and yet it is an opportunity which I welcome with humility and with intense enthusiasm. I am going to speak to you as though I were talking to myself for we have common problems, tasks and responsibilities. They stem partly from our basic origins as Americans, tracing back to Jamestown for some of you and to Plymouth for me. They stem partly from the fact that we are the living links in the modern United States of America to which the challenge of leadership to maintain freedom of man’s body, mind and spirit has been given for the foreseeable future. But they stem chiefly from the often forgotten fact that we are together guardians of a brief span of that greatest of all miracles — the progressive evolution of humanity from the purely animal type of life to the increasing awareness, revelation and acceptance of the spiritual order of life into our being.

Our country has grown and is growing very rapidly in numbers of human beings. Even if the present rate of population increase slows down, we shall still have to continue to face problems caused and continued by the proximity of great numbers of people to one another.

Population growth occurs so silently and naturally in a country like our’s, blessed with great natural resources and with effective public health methods, that we are not acutely aware of many of its consequences as individuals until they are felt abruptly like a baby on our family’s doorsteps.

What are some of the problems which appear to have come to stay, at least for many decades to come and perhaps for the duration of our civilization?

One is certainly a decentralization and a more widespread distribution

of access to adequate physical care, housing, and nourishment for all citizens from pre-natal life through old age. The majority of the adolescent and adult citizens are and should be capable of contributing individually all or the great majority of the effort needed for self-support. The weak, the sick and the aged will, however, continue to be the responsibility of the strong, the fit and the productive members of society.

We are already well on the road to the recognition of this problem and to the development of methods to attempt its proper solutions.

Here, however, we encounter the first great danger of overlooking, or of understanding, the need of a basic change in our present attitude.

In the early stages of meeting this problem, the opportunity to amass great personal wealth was available. The need of forced contribution of welfare funds through local and federal taxation was not apparent or, perhaps, did not exist. Voluntary contribution of the "haves" to the "have nots" appeared to be taking care of the situation.

But the situation changed. The mass of the unavoidably or of the deliberately dependent increased. The opportunity to develop pressure groups of many types and in many fields arose and was eagerly grasped by leaders to whom organization, exploitation and domination of their needy fellowman was meat and drink. These groups have taken over. They depend on status quo, continuing a pattern. It is in this stage of the problem that we find ourselves today and it is bad — very bad, indeed. All through evolution, forms of life that have become dependent on too rigid an organization of their controlling environment have died out or have stopped evolving.

Classic examples are ants, which are enslaved by their environment and dinosaurs, which were eliminated by a similar slavery.

Unless averted, this fate also applies with certainty to the mental and to the spiritual levels of man as well as to the physical. The slave to unchanging habit is doomed.

If we flash back for a rapid but searching; look at the life of those who made this country, we see one clear truth shining from it like a directed ray, penetrating the centuries and hitting our own daily lives with unweakened energy. What is that truth?

The progressive evolution and development of a democracy is not possible without the continuing and growing responsibility of the individual.

True, our forebears formed groups for protection of all who were in them. But these groups were the product of individual responsibility shared by all. They were formed to guarantee the opportunity for further



and greater individual effort and responsibility and not to smother it by selfish group pressure or replace it by group thinking or by the inertia and inactivity of group intradependency.

Without a living, active and hungry sense of individual responsibility in each of us, centralized restrictive and directive authority of the government with punitive control is the only eventual method of enforcing orderly rules of behavior.

We have only to remember the characteristics of our ancestry which give us our inborn nature to realize how foreign and unwelcome such a prospect should be to everyone of us.

If we have further doubts as to the validity of this conclusion with respect to group or government control many of us can, I am sure, recall our experiences and reactions under Prohibition. These represented an experiment in authoritarian control which, although not as "noble" as it was once described, was most certainly enlightening and prophetic as well.

The amazing and deeply disturbing fact is that there exists, and is increasing, all around us today a flood of clear and ominous evidence that we are forgetting or neglecting to take steps to correct and prevent this dangerous trend or current away from individual responsibility.

I should like to discuss briefly the present situation as I see it in three great fields of essential and continuing human effort in order to illustrate what I mean. These fields are Health, Education and Industry.

### *Health*

It is of first importance to recognize the fascinating and inspiring progress which has been made in the short span of our own lifetime in the control and prevention of disease.

When I was a child diphtheria, malaria, tuberculosis, polio (although not clearly identified), pneumonia, whooping cough, and a whole group of infectious diseases were killing people by the tens and hundreds of thousands.

Slowly but with consummate skill, medical research discovered the causes of these diseases and developed methods of curing or, even better, of preventing them. Anti-sera vaccines, mosquito control, antibiotics were developed and applied. The lethal infectious diseases no longer threaten man with the sudden and terrifying menace that they once did. Broadly speaking, they are under control.

But note the all-important fact that, without an active and widespread

increased sense of individual lay responsibility, this result could not have been attained, nor will it be maintained.

You and I and our children and grandchildren have to take the necessary steps to make ourselves readily and regularly available for prophylactic or curative treatment.

What is the nature of the present health problem?

The diseases remaining as unsolved and sobering problems are those which originate chiefly from causes inside of us — "built-in causes." These causes are very complex and difficult to detect, identify and analyze.

As examples of such diseases may be cited cancer, cardiovascular disease and mental illness. Each of these categories includes many distinct and different form of origin and expression.

Each of them demands to a very great degree individual lay responsibility and cooperation if we are to make significant progress toward its control.

Periodic health examination of all citizens, including those without symptoms of any sort, will have to be the established general procedure before knowledge of the earliest signs of departure from normalcy toward these diseases can be detected and can be corrected or checked.

One can recognize at once that the submission of the individual to periodic examination demands individual responsibility and cooperation. At least some of those of you here today will probably resent the idea.

The fact is, however, that with the growth of the population there will be steadily increasing numbers of those older people who will need to be cared for and treated for these constitutional types of ailment. The very nature of the diseases will force on us a type of increased individual discipline and responsibility in order to control and decrease the rate of pressure on our actual and potential resources for hospitalization and treatment.

In other words, as the numbers of dependents increase and the burden on the taxpayer for their support, either directly or through agencies, grows heavier, action as mentioned will have to be taken to decrease or control as much as possible the rate at, and extent to, which we allow these diseases to become clinical and critical. At these stages they require a maximum of both human and material facilities to care for them.

The point that I should like to emphasize is that the sooner each of us informs him or herself about this situation and the more he or she thinks about this situation, and the more he or she thinks about it before it becomes more acute, the wiser, easier, more rapid and more permanent the eventual solution will be.

There will of course always have to be organized groups as a part of our health problems and indeed as a part of our whole civilization itself.

Faculties and departments of medical schools, staffs of hospitals, societies, associations and colleges of surgeons and physicians, municipal, county, state, and federal departments of health are all examples of such groups.

The important fact to be remembered and actively accepted is that such groups are only as good as are, first, the motives of the individuals who comprise their leaders and membership and, second, the degree to which such groups are the servants of the individual man and not his brain or his conscience. The individual must assume responsibility.

The problem is to understand and maintain the proper perspective and relative functions and responsibilities of the group and of the individual so that each will cooperate with the other in the most constructive and creative action possible, but this again is your's and my responsibility and no one else's!

### *Education*

The last few decades have seen a remarkable development of professional group-interest activities among educators.

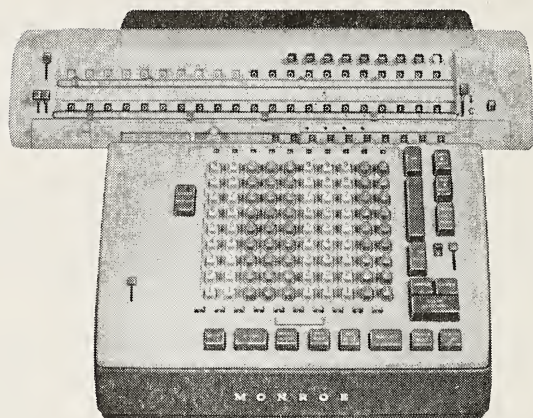
There has been and is a high and increasing degree of interest in devising rigid procedural rules, regulations and curricula with which compliance by prospective and practicing teachers is essential to appointment and promotion within the increasingly self-seeking profession of teaching and educational administration.

At the same time there has developed among students, at least those of college or higher grade, a disturbing tendency to expect more and more financial help for little or no greater intellectual effort or responsibility on their part as individuals. There is a growing interest in trading with, and in selling their mental potentialities to, the bidder that gives them the greatest material return for the least effort.

I do not mean that all students or all teachers have yielded to the group-privilege philosophy of life. There are many thousands still keenly aware of individual responsibility and of unselfish effort as an essential to true democracy.

I am sure, however, that all of us here today will admit that the tendency to accept group activity and group pressure as shapers of our thinking is alive and growing in education. Again — the correction of this trend depends on the responsibility of individuals like you and me.






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*Labor-Capital*

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The situation is critical and shocking in its own right but it gains in menace and in potentiality for fatal tragedy when we realize that it exists in a nation which, consciously or not, largely accepts economic power as its saviour. We can buy anything — good will — understanding — security.

When the labor unions were first organized, capital had selfishly and cruelly exploited the worker in at least several major industries and was abusing him in many others, large and small. The union was a much needed protector. However, even some of the very first labor leaders and organizers were themselves selfish and were motivated not by true interest in the worker but the potentiality of the organized group of workers as a producer of social and financial power and authority. Other leaders may have been motivated by more worthy ideas and emotions. At all events, good and bad together, the first efforts were highly successful in producing a new and vital type of group-interest organization based on class distinction and on fighting for an ever larger share of the money received by industry from its consumers and stockholders.

The protection of the health and of the basic earnings of the working man or woman — of labor so-called — is an objective with which no fair person can disagree.

The use of group influence and power to foster, and increasingly to advocate, a philosophy of more pay for less work is quite another matter.

All of recorded history through the centuries and indeed our own individual consciences, if they still function, tell us that this is a one-way street with an ever-increasing downward slope toward disintegration of the morale of any individual, family, state, nation or civilization.

There is no need to cite the growing number of cases of criminal exploitation of labor by its own leaders. There are individuals whose decay and putrefaction is recognized by our moral "nostrils." Eventually they will be punished and replaced.

What is far more dangerous is the largely unrecognized existence of a vast body of Americans who no longer believe in individual responsibility, whose workmanship has deteriorated, whose pride in the work of one's hands is dead or dying, and who have sold their birthright of individual responsibility for the pottage of group-privilege and patronage.

What a long and unhappy journey this is from the early days of our

country. The traits now applauded and advanced by labor and its followers as guides to democratic living would have led to the whipping post or to expulsion from community life in the old days and, remember, Americans in those days sired and guarded the troubled infancy of our country with hopes of a morally greater and more unselfish nation than we are building.

Can we by individual effort, slow down and later reverse this trend? Can we bring back into the heart, mind and daily life of both labor and capital the true meaning of giving instead of getting? Can we do anything to change a traditional attitude of suspicion, antagonism and the tragic failure of both to recognize that each of them — labor and capital — are really only two sides of the same great sheet of paper, namely, successful cooperative production and distribution of the material components of our civilization?

Of course, I do not claim to give a complete or perhaps even the best possible answer or answers to these socio-economic questions but I do wish to make a plea for certain things that each of us can do, at no material sacrifice, to increase the probability of such answers being made before it is too late.

What I shall propose is a challenge in a very real sense. It calls for increased individual effort. It accepts willingly the philosophy of the proven worth of individual responsibility and it proposes a way in which each of us, young or old in years, Virginian, New Englander, and all Americans can become partners in the effort .

So far we have been analyzing and evaluating some of the major factors that compose the trends that motivate the sociological and biological development of our country today. It is evident that these factors and trends apply to Virginia and are a part of its human environment just as much as the various natural resources about which we have heard are a part of its physical environment.

We have seen, I hope, that there is obvious and critical need for changing our democracy by the nourishing and increase of individual responsibility, if we are to evolve or, perhaps, even to survive as a nation.

What is needed is the kind of sense of individual responsibility which keeps asking, not "what is the least I can do?", but "what is the most?"

Here is where the fact that I am speaking to Virginians in Virginia makes me take heart.

Back of many of you lies the ancestry, and back of all of you the tradition that made this colony and state the birthplace and nursery of just



the sort of individual courage, devotion, tenacity and creative effort which make up the kind of individual responsibility to which I refer.

This is your precious heritage and should be your lodestar. There is no need for discouragement if we will face our individual opportunities frankly and unselfishly and with consecrated determination.

The great and good truth is that the elements that we need for recreation and establishment of this saving strength are, as I have said, attainable to every one of us — without material sacrifice.

To be on a firm foundation, our efforts to attain this strength must be guided by the acceptance of utilization of certain principles, certain basic truths that possess definite and definable qualities.

What are these qualities?

There are four of them without which our efforts will be in vain, but with which they will live and grow and spread and conquer.

The first principle is *SIMPLICITY*.

What we believe in and what we do in this effort must be so simple that it can be independent of any type or grade of informal education. What is involved is knowledge of a way of life and not the memorizing of facts recorded in books. What man's mind creates or builds by intellect alone can be destroyed by the superior intellects of enemies. What he builds by his way of life is his for all time.

The second principle is *UNIVERSITY*. What we believe in and what we do must be applicable to Jew and Gentile, black or white, Russian or American, rich or poor, young and old alike.

The third principle is *CONTAGIOUSNESS*. What we believe in and what we do must be lived by each of us and must be transferable to the lives of others by contact and by example. The written or graven word can be destroyed, the spoken word forgotten; the influence of a great and full life lives on in the lives of others.

The fourth and last principle is *SPIRITUALITY* — what we believe in and what we do must have the qualities of agelessness and of freedom from material attrition.

The greatest material structures of many hands or minds have crumbled. Purely intellectual theories, analyses, and explanation are disproved, replaced and discarded. The guiding spiritual truths lived by Brahmin, Buddha, the Hebrew prophets, Jesus, and other great spirits live on in ageless strength.

Each of us must, therefore, continually search our souls to ask, does

# Quality



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what I am about to believe and do have the essential qualities? Is it simple, universal, contagious, can I live it, and is it spiritual?

Insofar as these four elements are present, we are building as we can and should. Insofar as they are absent, still further efforts on our part are needed to find and to establish these lasting criteria of value.

But, you may say, this way of life is too idealistic — it is not practical. Let me hasten to assure you that it is not only practical but that opportunities to prove is practicality, to use and live it, are all around us, every-day, everywhere. In what areas shall we seek for, find and utilize these opportunities?

In our daily life for each of us there are four such areas of contact which necessarily span and define the unavoidable limits of our experience.

These areas are: (1) our contacts with the physical world in which we are living, (2) our contacts with other people, (3) our contacts with the infinite, and (4) the adjustment of these three areas of contact inside ourselves.

There is no other area of experience in which each of us in the whole world lives or can live.

For each and all of us, there is a single word or phrase for each area of contact that can be our safe and sure guide. We must remember that these "guides" must fulfill the requirements of basic values. They must be simple, universal, contagious and spiritual.

What are they?

In contacts with the world in which we live, *WORK* is the guide. This means far more than manual labor, although that is included. It means alertness, eagerness, enthusiasm, full use of the senses, in what we do with our hands, our heads and our hearts. The qualities of *WORK* so defined are simple, universal, contagious and spiritual. Each of you will recognize this as you think about it.

In contacts with other people, *LOVE*. "Love thy neighbor as thyself" means put yourself in his place and treat him as you would wish to be treated. This does not mean absence of criticism or blind compliance. It does mean tolerance and sympathy and understanding. Love meets completely the test of the four basic truths. It is simple, universal, contagious and spiritual.

In relation to the Infinite, *FAITH*. Here we must accept and live a childlike and unquestioning *FAITH* in the benevolence and love of a God



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who has stayed with and in man through his long and often painful and obstructed journey toward TRUTH and a more complete partnership.

This kind of faith will be hard to accept for many of us who are accustomed to include characteristic forms or ritual in our relations with the Infinite.

If, however, each of us is courageous and honest he will recognize that what all believers possess in common will have to become childlike in its confession of trust in, and love of, the God of whom we are aware, whom we can and do experience, and whom we cannot see with our eyes, or define, organize or dominate by our intellect.

It is only by the common acceptance of the childlike dependency of each and all of us upon this sort of FAITH that we shall become brothers spiritually in a way that will have real meaning and will contribute to the spiritual evolution of all mankind. Man has been told this by every great spiritual leader through the ages. It needs repetition and remembrances.

The adjustment of these three essential components of individual responsibility — WORK, LOVE, FAITH — inside of each of us requires a sense of BALANCE, or proportion and perspective. It also requires a sense of humor for most of our failures and stupidities in our various efforts must be recognized as being natural and temporary rather than critical or tragic.

The plea that I have made is for you to recognize the lasting power and potentialities of individual responsibility and its disturbing absence in our American thought and way of life. I have tried to define, direct and open roads to the happy and fruitful attainment of that responsibility.

In the more than three and a half centuries that have passed since the birth of our country there has been, and is being, a significant spiritual evolution of which each of us is meant to be a part. This evolution began long ages ago. It will continue until God's experiment either fails or leads to man's living with and in Him in peace, love and grace.

Remember always that out of the stark and cruel experiences of these first settlers, these new citizens of a new world; out of the menacing, encircling forests, the lethal invasive heat of the summers, the chilling, weakening cold of the winters, something very precious to our country and to us was born. This was the living proof of the power of individual responsibility.

And the fierce travail and labor pains of its birth were a lasting element in its glory. This suffering was a part of their individual lives which they accepted and, at least, overcame.

These men and women had set themselves a seemingly impossible task. First, to find, then to settle, and then to refine this new world as a home for what they held to be right and true.

This to them was to be first of all a world in which the individual not only recognized and met his almost overwhelming obligations but, and this is the immortal quality, sought for them, fought for them, and died for them.

Once this concept of our origin is admitted, the need of each of us today to examine honestly our own motives and practices becomes imperative without further delay in order to be sure that we are doing our part toward the re-birth of this responsibility.

So too, does the willing and enthusiastic adoption and living by guiding principles that will aid us in reaching and maintaining our optimum contribution toward this effort.

Clearly, this is a challenge to all Americans, but it is peculiarly applicable to all Virginians who should have justifiable pride in the history of individual achievement of their people throughout the birth and growth of our country, and who should rise to confess that pride by their own lives.

Just as your people and mine found that true Peace came from tireless, consecrated work and action — not from inaction and material fattening, so must we grasp life firmly and live it with all our physical, mental and spiritual energy until its end.

Just as your people and mine left material and social security to learn that not to fear insecurity brings a greater security, which is spiritual and which extends to others, so must we, without further delay, make the same journey, while there is yet time.

We must make it by living in Work and Love and Faith. Each step we take along that road will give us greater strength to take the next and, as we continue, we shall feel growing in us the renewing Truth that we in our time are being faithful to the great Power that enlightened those who went before and that seeks to enlighten those who come after us down the ages.



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Division of the manuscript into subheadings must follow a consistent plan. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashedline above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

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# THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE  
VIRGINIA ACADEMY OF SCIENCE

PROCEEDINGS FOR THE YEAR  
1961-1962



Vol. 13, New Series

September, 1962

No. 4



VOL. 13, NEW SERIES

No. 4

SEPTEMBER, 1962

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 13, NEW SERIES

No. 4

# VIRGINIA ACADEMY OF SCIENCE



Proceedings for the Year  
1961 – 1962

MINUTES OF THE FORTIETH ANNUAL MEETING

MAY 9-12, 1962

Host—Norfolk College of William and Mary

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C. T. O'Neill (1964)

H. R. Hanmer (1965)

### COUNCIL

#### *Elected Members*

P. A. Hansen (1963)	E. D. Brand (1964)	S. B. Williams (1964)
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G. T. Miller, Jr. (1963)	B. Harshbarger (1964)	J. M. Grayson (1965)
S. B. Row (1963)		E. F. Turner, Jr. (1965)

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P. B. Siegel

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#### *Past Presidents*

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W. B. Bell (1964)

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RESEARCH. R. D. Hughes (1963) *Chairman*, S. B. Williams (1964), B. Harshbarger (1965), E. C. Stevenson (1966), and W. R. Harlan (1967).

FINANCE AND ENDOWMENT. B. Harshbarger (1963) *Chairman*, E. Cox (1963), G. W. Horsley (1963), L. C. Bird (1964), S. S. Negus (1964), J. W. Cole, Jr. (1965), C. T. O'Neill (1965), R. F. Smart (1966), E. S. Harlow (1967), and H. H. Hobbs, Jr. (1967).

LONG RANGE PLANING. H. Leidheiser (1964) *Chairman*, D. R. Carpenter, Jr. (1963), J. W. Cole, Jr. (1963), W. S. Flory (1963), E. S.

Harlow (1963), B. Harshbarger (1963), W. M. Hinton (1963), G. W. Jeffers (1964), F. D. Kizer (1964), S. S. Obenshain (1964), S. B. Row (1964), J. C. Thompson (1964), W. B. Bell (1965), A. D. Campbell (1965), J. C. Forbes (1965), W. F. Guy (1965), P. B. Siegel (1965), and O. L. Updike, Jr. (1965).

MEMBERSHIP. E. S. Harlow (1964), *Chairman*, L. Quarles (1963), *Vice-Chairman*, W. P. Boyer (1963), *Vice-Chairman*, R. C. Berry (1963), R. B. Seligman (1964), L. C. Bird, (1965), M. A. Kise (1965), L. Heisey (1963), R. W. Engel (1964), F. D. Kiser (1964), B. English (1965), and R. Harrell (1965).

VIRGINIA JOURNAL OF SCIENCE. P. B. Siegel, *Editor*, C. W. Allen, *Managing Editor*, and F. L. Butler, *Auditor*.

RESOLUTIONS. Z. Black (1963), *Chairman*, J. H. Starling (1963), and H. G. M. Jopson (1963).

NATURAL RESOURCES. E. W. Mundie (1963), *Chairman*, W. S. Flory (1964), and H. P. Cotton (1965).

AWARDS. L. C. Bird (1965), *Chairman*, I. F. Lewis (1963), and W. T. Sanger (1964).

NOMINATING. W. M. Hinton (1963), *Chairman*, W. B. Bell (1964), and H. H. Hobbs, Jr. (1965).

VIRGINIA FLORA. A. B. Massey (1965), *Chairman*, L. Artz (1963), I. F. Lewis (1963), D. L. Crandall (1964), P. M. Patterson (1964), A. R. Shields (1964), W. S. Flory (1965), and R. Freer (1965).

SCHOLARSHIP. S. S. Negus (1963), *Chairman*, I. F. Lewis (1963), W. T. Sanger (1963), J. W. Beams (1964), L. C. Bird (1964), J. W. Whittemore (1964), E. Cox (1965), H. R. Hammer (1965), and B. Harshbarger (1965).

SCIENCE TALENT SEARCH. E. V. Russell (1965), *Chairman*, E. S. Higgins (1963), J. C. Holmes (1963), T. C. Heatwole (1964), F. D. Kiser (1964), and H. H. Garretson (1965).

JUNIOR ACADEMY OF SCIENCE. W. W. Scott (1964), *Chairman*, D. Blickenstaff (1963), W. W. Cash, Jr. (1963), V. Ellett (1963), R. Johnson (1963), J. H. Kepchar (1963), F. D. Kizer (1963), V. B. Remsburg (1963), J. J. Thaxton (1963), R. H. Dunn (1964), S. V. Floyd (1964), A. B. Niemeyer (1964), E. V. Russell, Jr. (1964), E. S. Grable (1965), J. Pugh (1965), M. S. Tischler (1965), D. Whitehead (1965), and E. L. Wisman (1965).

SCIENCE EDUCATION IN VIRGINIA. J. G. Barker (1963), *Chairman*, L. V. Heisey (1963), B. C. Via (1963), J. C. Forbes (1964), F. D. Kizer

(1964), J. C. Wells (1964), B. English (1965), J. W. Stewart (1965), and W. S. Woolcott, Jr. (1965).

HISTORY OF SCIENCE IN VIRGINIA. I. Boggs (1963), *Chairman*, I. F. Lewis (1963), E. Cox (1964), G. W. Jeffers (1964), W. G. Guy (1965), and S. S. Negus (1965).

PLACE OF MEETING. 1964—Charlottesville. R. D. Hughes (*Chairman*), J. C. Forbes, and J. J. Taylor.

1965—Richmond. W. W. West (*Chairman*), L. D. Abbott, and M. E. Kapp.

1966—S. M. Heflin (*Chairman*), C. S. Sherwood and J. Wells.

LOCAL COMMITTEE ON ARRANGEMENTS. Annual Meeting, May 1-4, 1963, Hotel Roanoke, Roanoke, Virginia.

General Chairman—B. Harshbarger, V. P. I.

Housing—B. E. Gushee, Hollins College.

Meeting Rooms and Equipment—A. Robey (*Chairman*), Roanoke College; J. B. Eades, V. P. I.; and S. S. Obenshain, V. P. I.

Junior Academy—C. E. Trent, V.P.I.

Registration—H. L. Holloway (*Chairman*), Roanoke College; L. Wine, Hollins College; and R. W. Engel, V. P. I.

Public Information—W. P. Bradley, V.P.I.

Commercial Exhibits—N. F. Murphy, V.P.I.

Industrial Tours—P. R. Thompson, General Electric Co. and A. T. Crowley, Norfolk and Western Railway Co.

Entertainment for Ladies—R. Painter, William Fleming High School and D. D. Montgomery, Hollins College.



## CONSTITUTION AND BY-LAWS OF THE VIRGINIA ACADEMY OF SCIENCE<sup>1</sup>

### CONSTITUTION

ARTICLE 1: *Name.* The name of the organization shall be the Virginia Academy of Science.

ARTICLE 2: *Purpose.* The purpose of this organization shall be to encourage scientific research in Virginia and to arouse interest in and appreciation of science among the people of the State.

(a) To discover, encourage and develop scientific interest and ability among the youth of the State by a Junior Academy of Science, by science clubs, by science talent searches and by other means.

(b) To facilitate prompt publication of acceptable scientific papers and abstracts.

(c) To cooperate insofar as practicable with industries in their scientific problems and with other scientific organizations having aims similar to this organization.

(d) To cooperate with those in charge of the Virginia State Science Museum and the Virginia Institute for Scientific Research.

(e) To render public service in scientific matters.

(f) To hold meetings of the Junior and Senior Academies for the better acquaintance of those interested in all branches of science in Virginia.

ARTICLE 3: *Members.* SECTION 1. There shall be eight classes of members: regular, student, contributing, sustaining, life, patron, honorary life and business.

SECTION 2. The first four classes of members are distinguished by the dues which they pay (see by-laws).

SECTION 3. Life members shall consist of members who, by paying the sum of one hundred dollars (\$100.00) are exempt from payment of further dues.

SECTION 4. Patrons shall consist of those persons who have given to this organization the sum of one thousand dollars (\$1000.00) or its equivalent in property. They shall have all the rights and privileges of regular members and shall be exempt from dues. An institution may also

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<sup>1</sup>Includes all revisions through the Academy Conference of May 10, 1962.

become a patron by meeting the above requirements. Its representative shall have all the rights and privileges of regular members.

SECTION 5. Honorary life members shall consist of persons elected by the Council for long and distinguished service to science in this organization and others no matter where located. They shall have all the rights and privileges of regular members and shall be exempt from dues.

SECTION 6. Business or industrial organizations, which pay dues of \$100.00 annually, shall be Business Members of the Academy. Such dues will be used in the annual operations of the Junior Academy of Science, The Science Talent Search, and other purposes as directed by the Council.

ARTICLE 4: *Election of Members.* Members of all classes except honorary life must be accredited by the Secretary-Treasurer of the Academy and/or the Council. See Article 3, Section 5, concerning honorary life membership.

ARTICLE 5: *Officers.* The officers of this organization shall consist of a President, a President-Elect, a Secretary-Treasurer and an Assistant Secretary.

ARTICLE 6: *Council.* The executive body of this organization shall be known as the Council. It shall be composed of the President, the President-Elect, the Secretary, the Treasurer, the Assistant Secretary-Treasurer, the three most recent Past Presidents, and one member elected by each Section of the Academy. The members from the several Sections shall be elected for three year terms, on a rotational basis among Sections. In addition to the above listed members, the following shall be ex-officio members of the Council: (1) the Editor, (2) the Chairman of the Long Range Planning Committee, (3) the Chairman of the Research Committee, and (4) the Chairman of the Committee for the Junior Academy of Science. In case of death or other unforeseen interruption of this routine, the President shall make interim appointments until the next annual election is held.

ARTICLE 7: *Duties of the Council.* The Council shall have charge of the policy of this organization and its funds and shall supervise the publication of its Journal, including the appointment of the Editor, Associate Editor, Managing Editor and Advertising Manager. The term of office of each shall be set by the Council.

ARTICLE 8: *Election of Officers and Council Members.* A nominating Committee, appointed by the President, usually consisting of the three immediate Past Presidents, shall submit to the annual meeting nominations for President-Elect, Secretary-Treasurer, Assistant Secretary, and for one or more members of the Council. Nominations from the floor shall be in order. These officers shall be elected annually by the membership and,

with the exception of the Secretary-Treasurer and Assistant Secretary, shall not be eligible to succeed themselves.

ARTICLE 9: *Sections and Affiliated Chapters.* SECTION 1. Any group of members may, with the approval of the Council, organize as a separate Section. Such a Section shall become established after it has conducted one successful program at an annual meeting. Any established Section which fails to conduct a program for two successive annual meetings may be dropped as a Section by action of the Council. Such a Section may be reestablished by the Council after it has conducted one successful program at an annual meeting. If any Section shall plan to adopt a constitution and by-laws, they must be approved by the Council prior to adoption by the Section.

SECTION 2. Any group of members may, with the approval of the Council, organize Affiliated Chapters wherever deemed necessary. Each new Chapter's constitution and by-laws must be approved by the Council prior to its official affiliation with this organization. Any amendments subsequent to affiliation must also be approved.

ARTICLE 10: *Meetings.* The annual meeting of this organization shall be held on the first or second Thursday, Friday and Saturday of May in each year at a place selected by the membership. The council shall decide whether the annual meeting shall be held the first or second Thursday, Friday and Saturday in May and shall arrange for any special meetings deemed necessary.

ARTICLE 11. *Business.* SECTION 1. Forty members of this organization shall constitute a quorum for the transaction of business at regular and special meetings. Seven members shall constitute a quorum for the transaction of business by the Council. No votes by proxy shall be cast at any meeting.

SECTION 2. The fiscal year of this organization shall be from January 1 to December 31.

SECTION 3. The parliamentary procedure of this organization shall be governed by Robert's Rules of Order, Revised.

SECTION 4. This constitution may be changed or amended at any meeting of the Council by a two-thirds majority of those present, subject to approval of the Academy Conference at the Annual Business Meeting provided due notice of such proposed change has been published in the Virginia Journal of Science or furnished in writing to the members prior to such annual meeting. The Council members shall be notified in writing thirty days prior to a Council Meeting of all contemplated changes to be proposed at that meeting.



## BY-LAWS

SECTION 1. *Annual Dues.* (1) The annual dues of regular members shall be three dollars (\$3.00).

(2) The annual dues of student members shall be two dollars (\$2.00) payable by July 1 of each year in advance and for which they shall receive *The Virginia Journal of Science* for that year. The sum of \$1.25 of the \$2.00 student dues shall go to *The Virginia Journal of Science* to cover the cost of student subscription.

(3) Members who pay annual dues of five dollars (\$5.00) shall be designated Contributing Members.

(4) Members and institutions which pay annual dues of ten dollars shall be designated Sustaining Members.

(5) A Regular, Student, Contributing or Sustaining Member in good standing must not be in arrears in dues for more than one year. Any such member not in good standing because of non-payment of dues may be reinstated upon payment of dues in arrears.

SECTION 2. *Duties of Officers:* (1) The President shall be the directing head of the Academy, shall preside at business meetings and general sessions of the organization, and shall appoint the members of the standing committees and of new committees authorized by the Council.

(2) The President-Elect shall assist the President as mutually agreed between them, and shall serve as president in the latter's absence. He shall furnish the Academy at its annual business meeting with a list of committee memberships which he has set up to assist him during his year as President.

(3) The Secretary-Treasurer shall keep a complete record of each annual meeting, and of other meetings held during the year by the Council, and shall prepare a report of their proceedings for publication. He shall keep the membership lists of the Academy in up-to-date fashion, shall promptly supply the Managing Editor of the *Journal* with the names of all new members and shall likewise supply the Managing Editor of the *Journal*, on January 1 of each year, with the list of all members whose dues are paid by that date. The Secretary-Treasurer shall receive all funds except as provided below under Section (5), (2), shall disburse all funds as directed by the Council and approved by the President and/or Chairman of the Finance Committee, and shall submit at the annual meeting a written report of all receipts and disbursements. His annual report shall be accompanied by an audit by a recognized public accountant. He shall furnish quarterly financial summaries to the officers and to the members of the Council and of the Finance Committee. He shall be adequately bonded.

(4) Officers shall serve ex-officio on all committees of the Academy.

SECTION 3. *Reimbursement of Officers*: The President and President-Elect shall serve without reimbursement. The Council, on recommendation of the Finance Committee, shall fix the salary of the Secretary-Treasurer annually.

SECTION 4. *Representation at Meetings*: Where representation at national meetings and on formal academic occasions is desirable, the President shall designate Academy representatives from among persons known to be planning attendance at those meetings. No officer or other Academy member shall receive compensation for attending meetings, scientific or otherwise, either within or without the state of Virginia—except for attendance of the Secretary-Treasurer, or in his absence some presidential designate, at the annual meeting of the American Association for the Advancement of Science, in order that the Academy may have a continuity of representation at Council Meetings of the American Association for the Advancement of Science. In the case of this exception, the upper limit of the representative's expenses, to be paid by the Academy, shall be round-trip railroad fare, plus a maximum of \$15.00 per day expenses.

SECTION 5. *The Virginia Journal of Science*: (1) THE VIRGINIA JOURNAL OF SCIENCE shall be the official publication of the *Virginia Academy of Science*, and as such shall carry approved articles summarizing scientific research work, appropriate news items (in as restricted a space as feasible), most announcements to the membership concerning Academy activities, and the Program for, and the Proceedings of, the Annual Meeting of the Academy.

(2) For each dues-paying Member, except Student Members, two dollars (\$2.00) shall be turned over to the *Journal* each year. When members in arrears pay back dues, two dollars (\$2.00) shall go to the *Journal* for each year in which the Member has been supplied with issues of the *Journal* while in arrears. Where members have pledged and paid two additional dollars, for each of the first two years of the reinstituted *Journal*, these monies shall be paid to the *Journal*. All monies accruable entirely to the *Journal* (such as subscriptions without memberships, advertisement revenues, exchange fees, gifts, etc.) shall be collectable by, and paid directly to, the *Journal*. The *Journal* shall finance itself from the above-mentioned amounts, and from such other sources as become available, and shall set aside such sums as possible for any future contingencies.

(3) All members shall receive the issues of the *Journal*. Subscriptions to the *Academy Journal* will be discontinued for those Students, Regular, Contributing, or Sustaining Members who have not paid their dues by January 1 of each year.

(4) The staff shall be composed of an Editor, an Associate Editor, Man-

aging Editor, and an Advertising Manager—all elected by the Council—and of Section Editors, with one representative, known as Section Editor, elected from and by each of the Academy's Sections. All members of the staff shall be elected for terms of five years (except that in reinstituting the *Journal* the several Sectional Editors were elected for terms of two, three, four, and five years, respectively, in order that a rotation of experienced editorial personnel might be assured.) In case of vacancies due to retirements, deaths, or other reasons, the positions shall be temporarily filled by the Council, from recommendations furnished by the Editorial Staff, until the time of the next Annual Meeting, at which time the positions shall be filled for the remainder of the unexpired terms by the groups responsible for the original appointments.

(5) The Editor shall receive all materials for the *Journal*, shall send scientific articles to the appropriate Sectional Editors for refereeing, shall act as a referee himself, and shall edit all material published in the *Journal*.

The Associate Editor shall aid the Editor in preparing materials for the *Journal* and in correcting proofs.

The Managing Editor shall keep mailing lists that are up-to-date, shall mail all *Journals* (including Proceedings), shall keep financial accounts on the *Journal*, shall pay all bills and care for all business, including an annual audit of Books of the *Journal*—subject to the regulations and approval of the Academy Council.

The Advertising Manager shall be responsible for securing the proper amount and type of advertising material for the *Journal*, and shall be responsible to the Managing Editor.

The Sectional Editors shall aid the Editor and Associate Editor in refereeing, and in securing additional referees for scientific articles within their respective fields; in preparing proper announcements and news items for the *Journal* and in such other ways as may be advantageous.

(6) No staff member of the *Journal* shall receive remuneration for either work or travel, but shall be supplied with such materials as are used in the way of stationery, postage and similar items.

SECTION 6. *Committees:* (1) The Research Committee shall be composed of five members, each appointed for a term of five years. One new member shall be appointed each year by the President to replace the member whose term will expire. The senior member of the committee shall serve as Chairman.

(2) The Council shall have the right to establish other appropriate standing Committees, and such special Committees as, and when, needed.

SECTION 7. *Changes in these By-Laws:* These by-laws may be



changed or amended at any meeting of the Council by two-thirds majority of those present, subject to approval of the Academy Conference at the Annual Business Meeting, provided due notice of such proposed change has been published in the *Virginia Journal of Science* or furnished in writing to the members prior to such annual meeting. The Council members shall be notified in writing thirty days prior to a Council Meeting of all contemplated changes to be proposed at that meeting.

### TABULATION OF REGISTRATION—1962 MEETING

SECTION	Members	Non-members	Total
Agriculture	28	21	49
Astronomy, Mathematics, & Physics	43	41	84
Bacteriology	13	7	20
Biology	77	65	142
Chemistry	70	36	106
Engineering	9	21	30
Geology	27	24	51
Medical Sciences	11	10	21
Psychology	24	45	69
Science Teachers	19	7	26
Statistics	13	7	20
No Section preference	16	123	139
	<hr/>	<hr/>	<hr/>
Totals	350	407	757
Registration of the Junior Academy			324
			<hr/>
Total Registration 1962 Meeting			1081

## MINUTES OF THE MEETING OF COUNCIL

## GOLDEN TRIANGLE HOTEL, NORFOLK

MAY 10, 1962

Dr. Hobbs called the meeting to order at 2:05 p.m. with the following present: W. B. Bell, Zoe Black, Isabel Boggs, E. D. Brand, W. H. Brittingham, J. T. Calver, Susie V. Floyd, J. C. Forbes, P. Arne Hansen, Boyd Harshbarger, W. M. Hinton, E. V. Russell, Jr., W. W. Scott, C. S. Sherwood, Paul B. Siegel, Foley A. Smith, Jackson J. Taylor, E. V. Turner, Jr., W. R. West, Jr., and Stanley Williams. Since the minutes of the last meeting had been published in the April, 1962 issue of the *Journal*, a motion was passed that they not be read at this time.

Dr. Hobbs reported that Mr. Jackson Taylor, president-elect, had represented the Academy at ceremonies held at Hollins College, when Dr. Logan was installed as president of the college. He thanked Dr. Harshbarger for his efforts toward securing Dr. Siegel and Dr. Allen as new editor and managing editor, respectively, of the *Journal*. Dr. Hobbs read from a letter in which Dr. Gwathmey expressed appreciation to the Academy for its \$1000.00 contribution to the Building Fund of the Virginia Institute for Scientific Research. Dr. Hobbs read a report from the committee he had appointed to consider the role of the Academy in recognizing—possibly by a suitable citation—an industrial firm in the State for an outstanding contribution to science. This committee of Drs. Guy, Negus, and Smart (Chairman), recommended: 1) that the Academy recognize a Virginia industry for an outstanding contribution to science by a suitable citation, 2) that no award be made in 1962, and 3) that the initial award be presented in 1963. During the discussion of this report questions were raised as to what would be the qualifications, how often the award would be given, and who would recommend a firm for the award. A motion by Dr. Bell was passed which provided that the incoming president request the committee to consider these and any other pertinent questions, and discuss them with the Awards Committee, and to make recommendations as to the “ground rules” and the mechanics of the Academy making such an award.

Mr. Taylor reported he had appointed new committee members where appropriate, and all matters relative to his succeeding to the office of president were progressing satisfactorily.

The Treasurer’s report showed a small anticipated surplus of receipts over expenditures for 1962.

Mr. Sherwood reported that all arrangements pertaining to the meet-

ing were proceeding satisfactorily. Dr. Hobbs thanked Mr. Sherwood and others on the committee for their most successful planning and arrangements for the meeting.

President Hobbs then reviewed the work of the Committees through their Chairman, where possible, for Council's acceptance before they were presented formally at the Academy Conference.

With respect to the Junior Academy's E. C. L. Miller Award the question arose as to its original intent. Dr. Scott reported that since he had been Chairman, the award had been given to the most outstanding club, but for some time prior it had been given to the Club Sponsor. Minutes at hand (back to 1950) did not date far enough back and the Secretary was asked to look the matter up and report at the fall Council Meeting. Council passed Dr. Bell's motion that the E. C. L. Miller award be given to the winning club, that two honorable mention of \$25 each be given, that the original intent of the award be investigated, and that Council act in the best interest of the award at its fall meeting.

During the discussion of the report of the Junior Academy of Science Committee, Dr. Scott stated that, with Council's approval, his committee planned to subsidize the teacher-sponsor scholarships by giving \$100.00, from Junior Academy funds, to the recipients for expenses. Council approved this proposal.

Dr. Hinton reported that the Awards Committee was not recommending any special awards to be presented at this annual Academy meeting.

The 1963 meeting had already been arranged to be held in Roanoke and the 1964 meeting to be held in Charlottesville. Dr. West reported that the Medical College of Virginia, Richmond Professional Institute, and the University of Richmond had invited the Academy to meet in Richmond in 1965, with these institutions as hosts. The Committee recommended that this invitation be accepted. Council approved this recommendation and voted that this be reported at the Academy Conference for action by the Academy membership.

President Hobbs inquired of the feeling of Council as to the place in the Academy which the Flora Committee should have. Dr. Harshbarger pointed up the work Dr. Massey has and is doing and indicated that the work of this committee would reflect honor on the Academy and should be kept as an Academy Committee.

Miss Boggs reported that the materials for a history of the Academy are in hand, and its publication is desirable. Council is in favor of this but wishes to look into the financial outlay involved.

For the future, Miss Boggs, recommends the writing of a history of Science in Virginia, that persons from various sections, or historians inte-



rested in this research constitute a reorganized Committee. Council passed Dr. Williams' motion that Council go on record as approving Miss Boggs recommendation that the slate of officers of each section include a historian.

Dr. Williams reporting for the Committee studying the advisability and feasibility of obtaining a full-time Executive Secretary reported he is working informally and he felt it should be gradually worked out.

Council approved Mr. Taylor's motion that the revision of Article 6 of the Constitution as published in the Journal Vol. 12, No. 4, Page 122, September 1961 be approved by Council for presentation at the Academy Conference that evening.

Council passed a motion by Dr. Bell that President Hobbs appoint a committee to study an additional amendment to Article 6 of the Constitution and bring in a recommendation at the May 12th Council Meeting concerning a suggestion that the Chairman of the Academy's Board of Trustees be made an Ex-officio Council Member.

Dr. Forbes called attention to lecturers available from learned societies and financed by the N.S.F. He reported that through the good offices of the University Center in Virginia Incorporated, Colonel Fitzroy secured 7 scientists that visited 14 colleges in Virginia.

Council passed Dr. Forbes motion that the University Center in Virginia be commended for their excellent work in making arrangements for the visiting lecture program and that the continuation of this favor be encouraged.

Dr. Turner suggested the possibility of adding to the Academy a section on the History and Philosophy of Science. Considerable discussion followed without action.  
Adjournment.

Paul M. Patterson, Secretary

William B. Wartman, Jr.

Assistant Secretary-Treasurer

MINUTES OF THE ACADEMY CONFERENCE  
GOLDEN TRIANGLE HOTEL, NORFOLK  
MAY 10, 1962

President Hobbs called the meeting to order at 8:00 p.m. as there were more than the required 60 members present for a quorum. The reports of the Academy Committees were read and adopted, except as indicated below. They are published elsewhere in this issue.

The amendment to the constitution concerning the membership on Council published on Page 122, in the September 1961 issue of the Journal was adopted unanimously.

An appreciation and grateful acknowledgement for the symposium on basic research on Virginia's Natural Resources was made by Dr. Hobbs. This symposium, arranged by Dr. Leidheiser, included outstanding authorities in several fields. The program may be seen in the April 1962 issue of the Journal on page 71.

Dr. Warwick R. West, Jr., reported for the place of meeting for the Academy for 1965, and recommended Richmond, Virginia. The Conference adopted the recommendation.

In Dr. Masey's absence, his report of the Committee on Flora was read by the Secretary. The last sentence, recommending the discharge of this Committee, was deleted by the Conference on the basis of the important contributions to our knowledge of the flora of Virginia that Dr. Massey is making. The Conference passed unanimously Dr. Flory's motion that the Academy go on record as recognizing and commending Dr. Massey's contribution to the flora of Virginia, and recognize the prestige gained by the Academy from this important work.

**Adjournment.**

Paul M. Patterson, Secretary

## MINUTES OF THE ACADEMY ASSEMBLY

## GOLDEN TRIANGLE HOTEL, NORFOLK

8:00 P.M., MAY 11, 1962

President Hobbs introduced Dr. Lewis W. Webb, Jr., President of the Norfolk College of William and Mary who read a welcome from Mr. W. Fred Duckworth, Mayor of the City of Norfolk and gave his own warm welcome from his College. Dr. Webb then presented a miniature mace from the city to Dr. and Mrs. Hobbs and one to Prof. and Mrs. Jackson J. Taylor. After an appropriate response, President Hobbs called on Dr. Taylor, Associate Administrative Secretary, A.A.A.S., who brought greetings from that organization to the Academy.

Dr. Zoe Black then read the resolutions prepared by the Resolutions Committee as follows:

Inasmuch as the members of the Virginia Academy of Science have assembled for their Fortieth Annual Meetings in the City of Norfolk, Virginia, from May 9 until May 12, 1962,

And inasmuch as these meetings are now drawing to a close,  
Therefore, it is deemed fitting that certain Resolutions, expressive of the sentiment of the members, be entered upon the minutes, namely;

Whereas, at the time of holding these Fortieth Annual Meetings, there are sixteen members who were among the one hundred and forty seven charter members who are thus completing their fortieth year of membership,

Be it resolved: that we send them the affectionate greetings of the Academy, together with our respect and gratitude for their unique and continuing service to the Virginia Academy of Science, to the Commonwealth of Virginia, and to the world of Science.

The present sixteen charter members are:

HAROLD L. ALDEN, University of Virginia, field of Astronomy

LLOYD C. BIRD, Phipps and Bird, field of Bacteriology

HARRIETT H. FILLINGER, Hollins College, field of Chemistry

L. G. HOXTON, University of Virginia field, of Physics

W. H. KEEBLE, Randolph-Macon College, field of Physics



WILLIAM A. KEPNER, University of Virginia, field of Biology

J. E. KINDRED, University of Virginia, field of Medical Sciences

CLAUDIUS LEE, Virginia Polytechnic Institute, field of Engineering

IVEY F. LEWIS, University of Virginia, field of Biology

LEONIDAS R. LITTLETON, Emory and Henry, field of Chemistry

ROBERT F. McCracken, Medical College of Virginia, field of Chemistry

CHARLES P. OLIVER, University of Pennsylvania, field of Astronomy

T. McN. SIMPSON, JR., Randolph-Macon College, field of Mathematics

IDA SITLER, Hollins College, field of Biology

CARL C. SPEIDEL, University of Virginia, field of Medical Sciences

EARL G. SWEM, College of William and Mary, field of Education

And, Whereas Horton H. Hobbs, Jr., has served as President of the Virginia Academy of Science during the 1961-1962 term, and has performed his duties faithfully and well, and has gone beyond his bounden duties in loyal service,

Be it resolved: that we hereby express to him our gratitude and deep affection.

And, Whereas the other officers, section chairmen and committee chairmen have executed their duties properly and efficiently,

Be it resolved: that we give them heartfelt thanks for tasks well done and for their patience in seeing to it that the work of the Academy ran smoothly.

And, Whereas the host College which was the Norfolk College of William and Mary, together with its President, Lewis W. Webb, Jr., and also the chairman of the Committee on Arrangements, C. S. Sherwood, and the members of that committee have received us graciously and have made most successful plans for our convenience and happiness,

Be it resolved: that we convey to them our sincere appreciation for their thoughtfulness and concern.

And, Whereas the management and staff of our headquarters hotel, The Golden Triangle, treated us with courtesy and housed us in comfort,

Be it resolved: that we express to them our appreciation for their efficient and cheerful efforts on our behalf.

And, Whereas the commercial exhibits arranged for these meetings have attracted much interest,

Be it resolved: that the Academy expresses its appreciation to the commercial companies represented, for their cooperation and for the excellence of their displays.

And, Whereas the roll of members has been decreased by several deaths,

Be it resolved: that the Academy notes with sadness these deaths,

W. E. Bullington

G. Talbot French

Irwin M. Gladstone

Harvey Haag (a charter member)

Isabel Harris

William Hartung

Lewis E. Harvie

John B. Lewis (The first emeritus member)

Penelope Lewis

Garnett Ryland

D. P. Scott

John W. Watson (a charter member)

Upon Mrs. Black's motion, these resolutions were adopted.

Dr. William Scott reported the important activities of and awards to members of the Junior Academy.

The following is supplemental to his report published elsewhere in this issue.

Eighteen cash awards, made possible by a grant from Phillip Morris, Inc., were presented at the Noon Annual Awards Hour to Junior Academy members in six science categories. In addition the following awards were made:

The Major W. Catsby Jones Award to Steven R. Mason, William Fleming High School, Roanoke, The Microbiology Award to Bernice Grant,

Maggie L. Walker High School, Richmond, The E. C. L. Miller Award to the Newport News High School Science Club whose sponsors are Misses Linda Allen and Betty Delbridge. The E. C. L. Miller honorable mentions went to the S. O. S. Science Club of Bedford High School sponsored by Mrs. J. J. Thaxton and the Science Club of the Lord Botetourt High School, Daleville, sponsored by Mr. Paul Garber. The AAAS Membership Award went to Miss Joyce Howell, Stewartsville High School, Goodview, and the VAS Membership award was given to David Leach, Jr., Bedford High School.

Teacher-Sponsor Scholarship Awards for 1962 were given to Miss Judith Stokes of Osborne High School, Manassas and Mr. Max Thomas of Floyd High School. Selections for the 1963 awards went to Miss Lyndale A. Pitt of Thomas Jefferson High School, Richmond, and Mr. John A. Malone of William Fleming High School, Roanoke, Virginia.

Junior officers elected for next year were President-elect, Robert Weems, Patrick Henry High School, Ashland and Secretary, Richard Bell, Norfolk Academy.

Dr. Warwick West announced the decision made at the Academy Conference to have the 1965 Academy meeting in Richmond.

Dr. Forbes, chairman of the nominating Committee, presented the following slate:

President, Jackson J. Taylor; President-Elect, Foley F. Smith; Treasurer, Rodney C. Berry, Sr.; Secretary, Paul M. Patterson; Assistant Secretary-Treasurer, William B. Wartman, Jr.; and for a three-year term on Council the sectional nominees, James McDonald Garyson (Section, Agricultural Sciences) and Edward F. Turner, Jr., (Section, Astronomy, Mathematics and Physics).

The secretary was instructed to cast a unanimous ballot for the slate as a motion was made and passed to close nominations when Dr. Forbes had presented the above slate.

Dr. Leidheier reporting for the Research Committee announced that the J. Shelton Horsley Award, selected from 14 competing papers was awarded to Claude P. Talley and Gerald R. Taylos, Jr., of Texaco Experiment Incorporated for their paper, presented before the Chemistry Section entitled "Preparation of high-purity single-crystal boron". Dr. Leidheier then announced that the Horsely Honorable Mention was awarded to Dr. William W. Scott of Virginia Polytechnic Institute for his paper to be given before the Biology section entitled "A monograph of the genus *Aphanomyces*." Dr. Tolley gave a brief review of the award winning research.



President Hobbs then introduced Dr. Dietrick Bodenstein, Head, Department of Biology, University of Virginia, the guest speaker, the title of whose address was "Hormones and the Development of the Insect Eye." His findings were well illustrated, interestingly reported and very well received.

Dr. Hobbs then turned the gavel over to the incoming President Jackson J. Taylor, who after appropriate remarks adjourned the meeting.

Paul M. Patterson, Secretary

## MINUTES OF THE MEETING OF COUNCIL

### GOLDEN TRIANGLE HOTEL, NORFOLK

10:00 A.M. MAY 12, 1962

President Taylor called Council to order with the following present: W. H. Brittingham (representing J. McD. Grayson), J. L. Calver, Susie F. Floyd, Boyd Harshbarger, W. M. Hinton, H. H. Hobbs, Jr., R. D. Hughes, Henry Leidheiser, Jr., G. T. Miller, Jr., P. B. Siegel, W. W. Scott, Foley Smith, E. F. Turner, Jr., W. B. Wartman, Jr., and S. B. Williams.

Dr. Hobbs reported for the Committee he set up at the previous Council Meeting of May 10th concerning the suggestion that under ex-officio members of Council the office of the Chairman of the Board of Trustees be added. Dr. Hobbs moved that the words "the Chairman of the Board of Trustees" be placed in Article 6 of the Constitution under "ex-officio members"; that this be a proposed constitutional change; and that the publication of these minutes be the prior publication as required by the Constitution for change of Constitution. Passed unanimously.

Under new business a discussion arose concerning another symposium such as the one at the current meetings dealing with conservation. High regard for the one given on May 10th was expressed. Several suggestions were made as to topics for the proposed symposium and suggestions made to insure its quality. Dr. Harshbarger moved, and Council passed the following motion, "that the President appoint a Committee to examine the possibilities for a future symposium on basic research with nationally known speakers on its panel and that the National Science Foundation be requested to support it."

The question of raising the stipend for the new Treasurer, Rodney C. Berry, Sr., was brought up. After some discussion it was agreed that the Finance Committee would look into the matter and report at the next Council Meeting.

Dr. Siegel reported that Mr. Frank Butler, a Certified Public Accountant has offered to audit the journal financial statements without charge. Council passed Dr. Harshbarger's motion to the effect that Council accept Mr. Butler's offer and recognize with appreciation that this service will be received without charge.

Dr. Turner, reporting for the Section on Astronomy, Mathematics and Physics, questioned the earliness of the date (February) for the call for papers. Various possibilities were suggested. The situation was reviewed but no action taken since only the title of the paper is due at that time and the abstract due on or before the May meetings. Council passed Dr. Harshbarger's motion that Dr. Turner write the section and explain this matter.

The question of collegiate membership was raised by Dr. Scott. It was pointed out that the Long Range Planning Committee had this subject under consideration. Dr. Taylor recommended that he and Dr. Scott and other interested persons could assist the L.R.P.C. in this matter.

The subject of requesting the legislature for collegiate scholarships or loan funds was raised again. Council felt that for various reasons this matter should not be pursued.

The question of the proposed Executive Secretary was raised again, (minutes of May 10, 1962), and after considerable discussion, Council passed Dr. Harshbarger's motion that Council dismiss the present Committee with thanks, and that Council take the matter into its own hands for further sympathetic consideration. Dr. Harshbarger had a suggestion for a possible Executive Secretary, and President Taylor asked Dr. Harshbarger to look into the matter further.

The next meeting of Council was set tentatively for 1:00 p.m., Saturday, October 13, 1962 at the University of Virginia, Charlottesville, Virginia.

Council thanked Dr. Hobbs for his fine leadership during the past year.

Adjournment.

Paul M. Patterson, Secretary

**REPORT OF THE TREASURER  
CONSOLIDATED FUND BALANCE SHEET**

(Prepared on Cash Basis of Accounting)

December 31, 1961

**ASSETS**

**GENERAL FUND:**

Cash in bank (Exhibit D):		
Unrestricted cash -----	\$ 4,554.69	
Restricted cash (Note 1) -----	2,500.00	\$ 7,054.69
Investments—at cost (Market Value		
\$2,224.75) -----		2,445.95
Due from Special Trust Fund -----		3,000.00
Due from Virginia Institute for Sci-		
entific Research Building Fund ---		800.00
Total General Fund -----		<u>\$13,300.64</u>

**RESEARCH FUND:**

Cash in bank (Exhibit C) -----	\$ 654.43	
Due from Special Trust Fund (Tem-		
porary Investment) -----	1,100.00	
Total Research Fund -----		<u>1,754.43</u>

**TRUST FUND PRINCIPAL:**

Cash on deposit (Exhibit D) -----	\$ 28.49	
Investment—at cost:		
U.S. Treasury Notes (Market		
Value \$3,008.40) -----	\$ 2,928.75	
Commercial Bonds (Market Value		
\$2,545.00) -----	3,025.00	
Stocks (Market Value \$28,843.88) --	10,805.90	16,759.65
Total Trust Fund Principal ---		<u>16,788.14</u>

**TRUST FUND INCOME:**

Cash on deposit (Exhibit E) -----	570.30
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**SPECIAL TRUST FUND PRINCIPAL:**

Cash on deposit (Exhibit F) -----	\$ 214.14	
Investments—at cost:		
U.S. Treasury Notes (Market		
Value \$5,111.00) -----	\$ 5,021.88	
Stocks (Market Value \$1,550.00) --	1,752.50	6,774.38
Total Special Trust Fund Principal		<u>6,988.52</u>

**SPECIAL TRUST FUND INCOME:**

Cash on deposit (Exhibit G) -----	142.75
	<u>\$39,544.78</u>

The accompanying notes to financial statements are an integral part of this statement.



## EXHIBIT A

## LIABILITIES AND FUND BALANCES

## GENERAL FUND:

Advance payment of dues -----	\$ 274.00	
James River Basin Fund -----	395.10	
Fund balance -----	12,631.54	
	<hr/>	
Total General Fund -----		\$13,300.64

## RESEARCH FUND:

Fund balance -----	\$ 1,754.43	
	<hr/>	
Total Research Fund -----		1,754.43

## TRUST FUND PRINCIPAL:

Fund balance -----	\$16,788.14	
	<hr/>	
Total Trust Fund Principal -----		16,788.14

## TRUST FUND INCOME:

Fund balance -----		570.30
--------------------	--	--------

## SPECIAL TRUST FUND PRINCIPAL:

Due to Research Fund -----	\$ 1,100.00	
Due to James River Project -----	1,600.00	
Due to General Fund -----	3,000.00	
Increment from Sale of Securities -----	1,288.52	
	<hr/>	
Total Special Trust Fund Principal -----		6,988.52

## SPECIAL TRUST FUND INCOME:

Fund balance -----		142.75
		<hr/>
		<u>\$39,544.78</u>

**INVESTMENTS HELD IN AGENCY ACCOUNTS**  
**FIRST & MERCHANTS NATIONAL BANK OF RICHMOND**  
**RICHMOND, VIRGINIA**

**DECEMBER 31, 1961**

**SCHEDULE A-1**

	<b>Book Value at Cost</b>	<b>Market Value</b>
<b>TRUST FUND PRINCIPAL ACCOUNT:</b>		
U.S. Treasury Notes, 4's, due May 15, 1963, \$3,000.00 -----	\$ 2,928.75	\$ 3,008.40
Household Finance Corp. Sinking Fund Debenture bonds, \$1,000.00 -----	1,025.00	925.00
Pere Marquette Railway First Debenture bond, \$2,000.00 -----	2,000.00	1,620.00
American Tobacco Company, Common, 40 shares	1,517.80	4,020.00
Atlas Chemical Industries, Common, 64 shares -	1,184.24	1,528.00
Illinois Power Company, Common 120 shares --	2,275.07	9,375.00
May Department Stores Company, \$3.75 Preferred, \$100.00 par value, 10 shares ----	1,080.35	780.00
Owens Illinois Glass Company, Common, 30 shares -----	1,353.87	2,880.00
Parke Davis & Company, Common, 135 shares -	1,597.57	4,944.38
Philip Morris, Inc., \$4.00 Preferred, \$100.00 par value, 7 shares -----	710.50	596.75
Standard Oil Company of New Jersey, Common, 93 shares -----	1,086.50	4,719.75
Total (Exhibit A) -----	<u>\$16,759.65</u>	<u>\$34,397.28</u>

**SPECIAL TRUST FUND PRINCIPAL ACCOUNT:**

U.S. Treasury Notes, 4¾'s, due May 15, 1964, \$5,000.00 -----	\$ 5,021.88	\$ 5,111.00
Westinghouse Electric Corporation, Common, 40 shares -----	1,752.50	1,550.00
Total (Exhibit A) -----	<u>\$ 6,774.38</u>	<u>\$ 6,661.00</u>

## J. WADDELL RISON &amp; COMPANY

*Certified Public Accountants*

609 INSURANCE BUILDING

Richmond 19, Virginia

MIton 4-4629

J. Waddell Rison, C. P. A.

Member  
American Institute of  
Certified Public Accountants

April 27, 1962

The Officers and Council Members  
Virginia Academy of Science  
Richmond, Virginia

Gentlemen:

We have examined the recorded cash receipts and disbursements of the Virginia Academy of Science, Richmond, Virginia, for the year ended December 31, 1961, and submit herewith our report thereon, consisting of the statements listed in the foregoing index. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and other such auditing procedures as we considered necessary in the circumstances.

The amounts shown on the Consolidated Fund Balance Sheet, Exhibit A, and Statements of Cash Receipts and Disbursements, Exhibits D, E, F, and G, relating to Trust Agency Fund Accounts, were taken from the December 31, 1961 report of the Trust Agent, First and Merchants National Bank of Richmond, and were not verified in any manner.

In our opinion, the accompanying statements prepared on a cash basis of accounting, present fairly the financial position of the Virginia Academy of Science at December 31, 1961, and the recorded cash transactions for the year then ended, on a basis consistent with that of the preceding year.

Respectfully submitted,

J. WADDELL RISON &amp; COMPANY

By: J. Waddell Rison  
Certified Public AccountantJWR:cj  
15/1



## REPORT OF THE FINANCE COMMITTEE

A meeting of the Finance Committee of the Virginia Academy of Science was held at the Commonwealth Club in Richmond, 6 March, 1962. Chairman Boyd Harshbarger called the meeting to order at 6:30 p.m. with the following members present: Dr. Guy Horsley, Mr. Edward S. Harlow, Dr. Jackson Taylor, and Foley F. Smith. Dr. Horton H. Hobbs, Jr., traveled from Washington to Richmond for the meeting, but due to the near blizzard conditions his train was delayed past the time of meeting.

The Academy income for 1961 was presented by the Treasurer, and this included the estimated income for 1962. This report is shown separately and is a part of the Minutes. It should be noted that the income for 1961 contained an anonymous bequest for \$2,500.00. This had to be reported as income, but this figure should be deducted from the grand total to give a more realistic figure of actual income. The estimated income for 1962 includes an estimate of twenty Business members, an increase of six over the present number. It was noted that the Philip-Morris Tobacco Company increased its annual gift to the Academy from \$750.00 to \$1,000.

A statement of disbursements during the period ending 31 December, 1961, was presented and compared with the approved budget in 1961. The proposed expenditures for 1962 were discussed in detail, and are presented below.

The expenditures over the approved budget for 1961, were \$236.87. \$200.00 of this represented a donation by the Academy to the Virginia Institute of Scientific Building Fund, and was not included in the 1961 budget.

It was moved, seconded, and passed that the subsidy to the Virginia Journal of Science for the Proceedings issue of the Virginia Journal of Science for Committee reports and 1000 program reprints for the Annual Meeting be increased to \$500.00. It was also moved, seconded, and passed that a past due bill for \$444.50, for publishing the 1960 Proceedings, and its reports be paid to the Journal.

It was moved, seconded, and passed that the proposed expenditures and budget be approved with changes as noted.

The meeting adjourned at 9:30 p.m.

Foley F. Smith, Treasurer

## REPORT OF THE INVESTMENT FUND TRUSTEES

*GENERAL ENDOWMENT ACCOUNT*

	Book Value	Market Value
Amount invested in Bonds—		
Government and Corporate .....	\$ 7,910.85	\$ 7,490.00
Amount invested in Preferred		
Stocks .....	1,790.85	1,402.00
Amount invested in Common Stock .....	9,393.45	27,690.00
Miscellaneous .....	150.00	150.00
	<hr/>	<hr/>
	\$19,245.15	\$36,732.00
Cash Principal .....	42.99	42.99
	<hr/>	<hr/>
	\$19,288.14	\$36,774.99

Estimated Annual Income ..... \$1,303.00

Cash Income Balance ..... 216.24

*SPECIAL ACCOUNT*

Amount invested in Bonds—		
Government .....	\$ 5,021.88	\$ 5,150.00
Amount invested in Common Stock .....	1,752.50	1,440.00
	<hr/>	<hr/>
Cash Principal .....	6,774.38	6,590.00
Cash Principal .....	214.14	214.14
	<hr/>	<hr/>
	\$ 6,988.52	\$ 6,804.14

Estimated Annual Income ..... \$ 286.00

Cash Income Balance ..... 12.00

Total book value of investments as of 3/21/62 ..... \$26,276.66

Total market value of investments as of 3/21/62 ..... \$43,479.13

Lloyd C. Bird, Chairman

*REPORT OF THE LONG RANGE PLANNING COMMITTEE*

Since the 1961 Academy Conference the Long Range Planning Committee has held one meeting at Lexington on May 12, 1961, and another at Charlottesville on November 12, 1961. Several recommendations to Council have resulted, some of which were approved by the Council on May 13, 1961, and others being considered by Council on November 19, 1961.

It was suggested that the recently approved Committee on the Teaching of Science be composed of 9 members, with three being appointed each year, as three others rotate from the group (approved by Council on May 13, 1961). It was recommended that the committee be composed of persons representing the various fields of science, including science teachers. Functions of the committee were visualized as being quite broad, and including studies on certification requirements, science teaching loads, and almost any problem of science teaching in the state. At the November 12 meeting it was suggested that this committee might have a more applicable and appropriate name than that first indicated, and that possibly such a thought would be covered in the name "Science Education Committee."

Council referred to the L.R.P. Committee a request by one Academy Section for funds for invited speakers. It was the unanimous opinion of the Committee that the funds for such an activity were not available within the present Academy financial and budget structure, and that this was a problem that should be solved by the several sections.

The Committee recommended to the Council that the constitution and by-laws of the Academy be made more easily found and accessible by the members. This to be done: (1) by having the annual Academy Booklet carry a notation to the place where the last complete printing of these articles can be found in the Journal, and (2) by printing the Constitution and By-Laws in complete form, with all changes and corrections and amendments to date, in the Proceedings for 1962 and thereafter in Issue No. 1 of The Journal in each year divisible by 5 (1965, 1970, etc.). (Approved by Council May 13, 1961).

Council referred to the L.R.P.C. a recommendation, received from two members of the Academy, concerning the setting up of places for the Annual Meeting at Roanoke, Richmond and in Tidewater Virginia, on a definite rotating schedule. The Committee reported to Council that apparently the Academy is now approximately meeting—in rotation—in the indicated areas; that it felt there were distinct advantages from the stand-points of scientific environment, of meeting room facilities, of lowered costs, etc., from meeting at educational institutions when feasible; and, in essence



that it considered our present general plan of meeting places is preferable to the recommended one. The L.R.P.C. did recommend to the Council, and the President, that the "Place of Meeting" committee might profitably be asked to consider not just the place for one additional meeting (say for 1964), but also to make a coordinated survey of past and possible future meeting places—not overlooking the desirability and possibilities of meeting in the populous Northern Virginia Area when feasible.

The L.R.P.C. made recommendations to Council concerning the newly approved Natural Resource Committee. It was recommended that the new committee's objective should be a progressive, or constructive, one within the terms of the statement "the encouragement of the industrial development of Virginia, within a framework of *wise resource use*." The purpose and objectives of the committee, as recommended, would include—among other things—(1) a progressive, orderly and essentially non-wasteful use of our economic and industrial natural assets of land, water, minerals, etc.; along with (2) the thoughtful preservation both of our unreplaceable regions of natural beauty, and of our most valuable biological areas; and (3) a consideration of factors involved in the control of water and air pollution. In other words the committee would serve to aid and encourage industrial expansion, while also encouraging a minimum of disfigurement and wasteful exploitation of irreplaceable assets—in the industrialization process. It was further recommended that originally the committee be composed of three persons with appointments respectively of 1, 2 and 3 years, with subsequent appointments to be for terms of 3 years each. It was further recommended that committee appointments be made from fields to secure representation of the interests of (1) industrial uses, (2) biological uses and (3) the public uses of Virginia's natural resources. These recommendations were made with the thought that the new committee, with its broader objectives would cover and include the work of the former "Resource Uses Committee." The recommendations with respect to the Natural Resource Committee were appointed by Council on November 19, 1961.

The Committee recommended to Council that the officers of the Academy be requested to investigate appropriate ways in which the Virginia Academy of Science might encourage the improvement and expansion of student loan funds by the Commonwealth of Virginia. This also was approved by Council.

Walter S. Flory, *Chairman*

## REPORT OF THE MEMBERSHIP COMMITTEE

### SUBCOMMITTEE FOR INDIVIDUAL MEMBERS

The subcommittee for Individual Members of the Virginia Academy of Science has set for its objectives for the year:

1. Continuing the drive for additional members

2. A canvas of the membership to secure current data on position, committee preferences, and availability for high school science assistance.

Continuing the policy employed last year, the Vice Chairman of this subcommittee requested the members of the subcommittee to furnish lists of potential members for the Academy. Each of those suggested was sent an invitation to join the Academy and descriptive material on its activities. As the applications were mailed to the Secretary, it is not possible to determine just how many of the applications received by the Academy were due to the activities of the Membership Committee, but according to the records of this subcommittee 58 new members had joined the Academy by May 1.

The second objective of the subcommittee was implemented by mailing a double card to all members of the Academy. This card requested the completion of the reply half and the return to the Vice Chairman of the committee. These cards were mailed in April and to date approximately 300 replies have been received. The results are being tabulated. It is hoped that in some way information on those willing to assist high school science classes, either in projects or by talks, may be made available to the high school science teachers of the state. The exact mechanism for this has not been determined, but it is gratifying to note that the majority of the cards returned indicate a willingness on the part of the member to render this service

Lawrence R. Quarles, *Vice Chairman*

## REPORT OF THE RESEARCH COMMITTEE

During 1961-62 a single request for a Research Grant was received by the Research Committee. Dr. C. E. Shull, Head, Mathematics and Physics Departments, Bridgewater College, requested a grant of \$500 for the "purchase of reference books." The Committee postponed a decision on this request at its meeting of May 1, 1962 in order to determine if this request meets the requirements for a research grant. A decision will be made at a meeting called for May 11.

Fourteen papers in the fields of chemistry, biology, astronomy, sta-

tistics, and medical sciences were submitted in competition for the J. Shelton Horsley Research Award. The winning paper will be announced at the Academy conference on May 11. An honorable mention award will also be made for a paper considered sufficiently meritorious by the Committee to deserve this distinction.

### *Subcommittee Business Memberships*

In 1961, there were 14 paid up business members in the Virginia Academy of Science. They were:

A. H. Robins Company, Inc.  
Allied Chemical Corporation  
The American Tobacco Company  
The Dow Chemical Company  
General Electric Company  
Larus & Brother Company, Inc.  
Merck and Company, Inc.  
Philip Morris & Co., Ltd., Ind.  
Newport News Shipbuilding Co. Foundation  
Norfolk and Western Railway Company  
Phipps and Bird, Inc.  
Reynolds Metals Company  
State-Planters Bank of Commerce & Trusts  
Virginia-Carolina Chemical Corporation

Generally, this was a representative group of Virginia industries. However, more industrial support for the Academy seemed justified.

During this year, plans were made for a wide solicitation of industries in the state. Through a descriptive letter and personal contacts, 48 companies and 15 banks were informed of the VAS program. As a result of this campaign, six new business members joined the Academy. They were:

Albemarle Paper Mfg. Co.  
Dan River Mills, Inc.  
E. I. du Pont de Nemours Co.  
First and Merchants National Bank  
Southern Materials Company  
Virginia Chemicals & Smelting Co.

One former member, Merck and Company, resigned leaving a net total of 19 business members as of today. It is hoped that several other prospective companies interested in the Academy will join before the end of the year.

William P. Boyer, *Vice Chairman*



## Financial Statement (Unofficial)

Cash on hand, January 1, 1962 .....	\$ 654.43
Receipts, January 1-May 1, 1962 .....	620.30
Cash on hand, May 1, 1962 .....	\$1,274.73

Estimated additions to funds prior to  
December 31, 1962

AAAS Grant .....	\$260.00
Interest earned by July 5 .....	550.00

Henry Leidheiser, Jr., *Chairman*

## REPORT OF THE JUNIOR ACADEMY OF SCIENCE COMMITTEE

As Chairman of the VJAS Committee, it is my pleasure to report to the membership of the Virginia Academy of Science a summary of our activities during the past year.

As most of you no doubt realize, these meetings mark the close of our 21st year. We feel that it has been a most successful one. Our membership now include a 53 permanently affiliated high school and community science clubs with a total membership of well over 3500 members and sponsors.

For some time the VJAS Committee has felt that considerable time and effort was being wasted in preparation for the traditional science fair type of program. We have felt that the objectives of the Junior Academy could best be accomplished by directing our efforts toward the better students—those with an interest in research—those students with original ideas and those capable of independent thought.

With this objective in mind, the VJAS Committee for the first time has eliminated the Junior Science Day Program and has offered the students an opportunity to present the results of their research as formal papers in a manner similar to that conducted by the Senior Academy. A total of 151 papers presented today during 5 concurrent sessions, seems to justify the changes we have made.

Awards totaling more than \$600 will be presented to those students judged to be outstanding in the various scientific disciplines at our Annual Awards Hour, Friday, May 11th, at 12:30 P.M. Senior Academy members are cordially invited to attend this meeting. These awards were made possible by a \$1000 contribution from the Philip Morris Company, Inc.

The Junior Science Bulletin, financed by a \$300 contribution from the

American Tobacco Research Laboratory, was published twice during the past year. Approximately 3000 copies were mailed to all secondary schools in Virginia. This bulletin was prepared by the junior officers and edited by Mr. A. B. Niemeyer of Churchland High School.

During the past year informational and promotional materials were mailed 5 times to over 600 public and private secondary schools throughout the state. Affiliated science clubs were provided with a permanent charter, individual membership cards, and a booklet entitled "A Guide for Science Clubs".

The annual meeting of the VJAS is being held in conjunction with this meeting of the VAS. A general meeting was held Wednesday evening which included an illustrated lecture by Dr. I. D. Wilson, Professor Emeritus of the Biology Department at V.P.I. The VJAS Annual Lecture is being held concurrently with this meeting with Dr. Charles W. Shilling, Director of the Biology Communications Project of the AIBS, as the principal speaker.

I would like to take this opportunity to thank the VAS Council and membership for their splendid cooperation during the past year and to express my sincere appreciation to the members of the VJAS Committee for a job well done.

William W. Scott, *Chairman*

## REPORT OF SCIENCE TALENT SEARCH COMMITTEE

This report will be given in a brief summary:

114 partially scored entries were received from Science Clubs of America in February. These entries were screened by the Reading Committee and the top 45 were selected. These individuals were invited to the Virginia Academy of Science Meeting in Norfolk. At the Academy Meeting an Interview Committee selected the top 15 individuals who were designated as Winners in the Virginia State Science Talent Search for 1962. The other individuals who were not winners were designated as Honorable Mention.

Twenty-one Virginia colleges and universities have cooperated and are offering scholarships to the Winners and Honorable Mentions.

The following lists are attached:

1. Reading Committee membership,
2. Interview Committee membership,
3. List of individuals invited to Virginia Academy of Science Meeting,

4. List of colleges and universities offering scholarships,
5. List of Winners and
6. List of Honorable Mention Finalists

E. V. Russell, Jr., *Chairman*

Editor's note. Prof. Russell has agreed to supply upon request the list of colleges offering scholarships. This list includes the number, renewability and value of the scholarships offered.

#### REPORT OF THE SCHOLARSHIP COMMITTEE

The Scholarship Committee of the Academy worked during the past year as usual mostly with high school teachers. Most science teachers in the State are now aware of scholarships available for their good students in at least Virginia institutions of higher learning. Most high school libraries now have copies of a bulletin of the State Department of Education entitled "Financial Assistance to Attend Four-Year Colleges and Universities in Virginia." Another reference bulletin which should be available in every four-year high school in the State is "Financial Aid to College Students: Undergraduate. It may be obtained for a dollar from the U. S. Government Printing Office, Washington 25, D. C. This directory lists more than a thousand institutions by States with scholarships, loans, fellowship, and assistantships available for qualified students.

One area not sufficiently reached by the National and Virginia Science Talent Searches, the Virginia Junior Academy of Science, and this committee has been the smaller country high schools where there must be scores of brilliant and needy seniors lacking guidance in securing financial aid for attending colleges.

Members of the committee individually have endeavored to secure college scholarships for 18 high school students in Virginia and 3 outside the State. Most assistance in this respect has come from high school science teachers who have done a wonderful job in Virginia in seeing to it that their capable and needy students do not lack opportunities for college educations if they are alert enough to take advantage of them.

Sidney S. Negus, *Chairman*

#### REPORT OF THE COMMITTEE ON VIRGINIA FLORA

The members of the Committee are continuing pretty much as previously reported. Miss Artz is concerned with the floristics of Shenandoah and adjacent counties with emphasis on the Massanutten Mountains. Freer



is active in the northern Blue Ridge Mountains. Patterson has given special consideration of the Virginia mosses and also conducted some physiological studies. Flory, working with graduate students, is especially active in genetics of native plants as well as exotic species. Miss Crandall is conducting an ecological and floristic investigation in a Piedmont area. She and Chamberlain are cooperating, he devoting attention to the animal life. Shields has been investigating the ecology and floristics of Beartown Mountain in Russell Co. and floristics of other counties of southwestern Virginia. His Beartown Mountain studies are the basis of a doctorate dissertation which he presents to the University of Tennessee in June. Massey has compiled an annotated catalog of the plant taxa which have been recorded in Virginia. The habitat and county record of each of more than 3500 taxa are recorded. These are based on publications as well as specimens in herbaria. The catalog has been published by the Virginia Agricultural Experiment Station, entitled *Virginia Flora*, Technical Bulletin 155, Dec. 1961. A 56 page paper by Allard & Leonard on the floristics of the Triassic area in the upper Piedmont of Virginia appears in the March 1962 issue *Castanea*. This is an important contribution to our flora. Its publication was made possible by a grant from the Flora Committee. Dr. Robert Kral, who has taken over Massey's position at V. P. I. is a Taxonomist, actively working on the flora.

A. B. Massey, *Chairman*

## REPORT OF THE HISTORY OF SCIENCE IN VIRGINIA COMMITTEE

### I. Committee aims: to fulfill a two-part assignment.

- A. To compile material on the origin and activities of the present Virginia Academy; i.e., to compile a *History of the Academy*.
- B. To compile material concerning the contributions to science by Virginia scientists, from the earliest days to the present. A *History of Science in Virginia*.

### II. Progress Report: History of the Virginia Academy of Science.

1. All section reports are at hand or promised for today.
2. All special reports are at hand or promised for today.
3. The general history is lined up by George W. Jeffers.
4. Russell J. Rowlett, Jr., of VISR has agreed to edit all material and to put it into form for publication by early autumn.
5. The publication will complete the first part of our assignment; it will cover the first forty years of the Virginia Academy.

## III. Further Assignment: History of Science in Virginia.

The steering group of the committee makes these suggestions:

1. that the preparation and maintenance of such data is our professional obligation and
2. that it is also a responsibility of the Academy.
3. that only those truly interested in such research should be asked to undertake it.
4. that therefore it may be best to reorganize the present History Committee so as to include only those who welcome such research.

## IV. Recommendation:

Because history is a continuum, the committee recommends that the slate of officers of each section include an historian. In this way a continuous record of sectional contributions may be kept for use in the next volume of the History of the Academy whenever needed.

## V. Archives.

In 1950 the Academy Council accepted an offer made by Allan T. Gwathmey, subject to the approval of the Board of the Virginia Institute for Scientific Research, that the Academy archives be housed in the VISR. However, crowded conditions in the VISR caused postponement. Now, Henry Leidheiser, Jr., Director of VISR, has re-offered space for the archives in the VISR quarters at present under construction.

All of the material handed in by members of the History Committee will be kept in the archives with other records.

## VI. Acknowledgements

1. To the many busy men who have served on the History of Science in Virginia Committee and who have made possible the accomplishment of the first assignment I offer the sincere thanks of the Academy, and of the Chairman.

Isabel Boggs, *Chairman*

## REPORT OF THE PLACE OF MEETING COMMITTEE

The Place of Meeting Committee determined that Richmond was the logical location for the annual meeting of the Virginia Academy of Science in 1965.

An invitation to hold the meeting in Richmond in 1965 has been extended jointly by the administrative officials of the Medical College of Virginia, Richmond Professional Institute, and the University of Richmond. Letters to this effect are in the hands of the President of the Academy.

The committee recommends that the invitations be accepted.

Warwick R. West, Jr., *Chairman*

## SECTION OF AGRICULTURAL SCIENCE

Carl W. Allen, *Chairman*

Lawrence I. Miller, *Vice Chairman*

T. Graham Copeland, *Secretary*

Paul B. Siegel, *Section Editor*

### MINUTES

The fortieth annual meeting of the Virginia Academy of Science was held at the Golden Triangle Hotel, May 9-12, 1962. The Agricultural Section met May 11, 8:20 A.M. in the Jefferson Room for presentation of papers. The morning session of the meeting was called to order by Chairman Allen. Dr. Allen gave a welcome and appointed the nominating committee consisting of Maurice B. Rowe, Sam F. Thornton and Wm. H. Brittingham, Chairman. The meeting adjourned for lunch at 12:05 P.M. The afternoon session was called to order at 1:15 P.M. by the Vice-Chairman Lawrence Miller. The final paper was completed by 4:40 P.M. Dr. Miller then called the business meeting. The Nominating Committee recommended the following for officers of the Agricultural Section for 1962-63. Lawrence I. Miller, Chairman; T. Graham Copeland, Vice-Chairman; Edward A. Borchers, Secretary; Grant W. Thomas, Section Editor; and James M. Grayson, member of the Council for 1962-65. These men were elected as officers for the year 1962-63. The meeting was then adjourned by Dr. Miller.

T. Graham Copeland, Jr., *Secretary*

## SOIL AND WATER CONSERVATION NEEDS OF VIRGINIA

J. K. Abernathy, *Soil Conservation Service, Richmond*

The Virginia Inventory of Conservation Needs was part of a study of each county in the nation. The approach used was to secure factual information about the properties, capabilities and present use of the soils by a 2% random sample. Based on this and other related information county committees made predictions as to the expected land use in 1975—by land classes and kinds of problems or hazards. They then estimated



the acreage adequately treated (or not feasible to treat), the difference being the acreage needing conservation treatment by 1975. Acreage expected to be converted to another land use was shown as needing treatment in the new use. Uniform procedures were used nationwide.

The Virginia estimates indicate a 9% decrease in cropland, a 5% increase in pasture, with woodland about the same and some 0.4 million acres going to non-agricultural uses. Sixty-two percent of the cropland and 60% of the pasture acreage needs additional conservation treatment. Thirty-five percent of the woodland needs stand improvement and 6% needs establishment or reinforcement. The Inventory also shows the kind and intensity of the conservation problem.

#### CONCEPTION RATES IN BEEF COWS AS AFFECTED BY INBREEDING OF FETUS, AND BY AGE AND INBREEDING OF COWS

K. P. Bovard and B. M. Priode, *Beef Cattle Research Station, Front Royal*

Inbreeding of fetus and of cow have detrimental effects upon conception rate. Intra-sire regressions of conception rate upon Fx of fetus, and upon Fx and age of cow were statistically non-significant, but with algebraic signs like those of similar studies in other species. Among Angus cows bred in 1961, average Fx values of fetus and of cow were 11.9% and 6.5%, respectively, for 137 pregnant cows, but were 17.3% and 10.3%, respectively, for 22 open cows. Similar data for Shorthorns bred in 1961 were: 14.7% and 9.0%, respectively, for 126 pregnant cows, and 21.0% and 10.1%, respectively, for 20 cows diagnosed not pregnant.

#### FERTILIZER DISTRIBUTION PATTERNS FROM BULK SPREADER TRUCKS

F. M. Cunningham, *Agricultural Engineering Dept., V. P. I.*

M. B. Rowe, *Virginia Dept. Agriculture, Richmond*

Before satisfactory distribution patterns can be formed with bulk spreaders, fertilizer must first be accurately metered and delivered to the boom or spinner distributors. While the metering accuracy of bulk spreaders studied was generally satisfactory, problems in proper delivery are common. Poor maintenance and adjustment of chutes for the delivery to booms and spinners adversely affected the performance of all spreaders studied. Conveyors on compartmented trucks were found to give better performance if geared to ground speed rather than to a constant speed source.

Proper adjustment of boom and spinner spreaders was also important in obtaining satisfactory distribution pattern uniformity. With proper adjustment, it was determined that the uniformity obtained with bulk spreaders on level fields approaches the uniformity from conventional tractor spreaders and liquid sprayers.

Both boom spinner spreaders were found to cause separation of blended fertilizer materials. Analysis of the trajectories of particles of materials spread with spinners shows that the product of particle diameter, as determined by sieve analysis, and particle density is the critical factor influencing the extent of separation.

## RESPONSE OF HORNWORM MOTHS TO NARROW BAND IRRADIATION

U. F. Earp, *Virginia Polytechnic Institute*

Tobacco and tomato hornworm moths were irradiated with monochromatic energy of approximately 100 Angstroms mean width. The energy bands were centered at 3129, 3654, 4047, 4358, and 5461 Angstroms. Six moths of known species and sex were placed in individual compartments of a special air conditioned chamber. After a dark adaptation period each was treated in a one-minute cycle consisting of irradiation for 10 seconds, resting 15 seconds, irradiation for 10 seconds, then resting and changing equipment for 25 seconds. Each was treated at each of the five energy bands, in random order, before the next moth was moved into position. The energy was obtained from a grating monochromater. Observations were made of each moth through an infrared telescope. Intensity of irradiation was measured with a photometer.

Energy bands in the ultraviolet and short-wave visible regions elicited equal responses. Less response resulted at 5461 Angstroms. More response was gotten at 75 F. than at 55 F. The responses at 40 and 60 percent relative humidity were the same and were significantly lower than the responses for 80 percent.

## OBSERVATIONS ON EXCYSTATION OF POULTRY COCCIDIA

Marion M. Farr and David J. Doran, *U.S.D.A., Beltsville, Md.*

*In vivo excystation of chicken and turkey coccidia*—Examinations of crops, gizzards, and intestines of chickens fed oocysts of either *Eimeria acervulina* or *E. tenella*, and of turkeys fed oocysts of either *E. meleagritus* or *E. gallopavonis*, indicated (1) that the oocysts were apparently

unchanged in the crop, (2) that in the gizzard a large proportion was broken and the sporocysts released, (3) that the freed sporocysts were carried on into the small intestine where their sporozoites became activated and escaped through a micropyle in the sporocyst wall. The sporozoites of the two duodenal species (*E. acervulina* and *E. meleagridis*) excysted more quickly and farther anteriorly in the intestine than did those of the two cecal species (*E. tenella* and *E. gallopavonis*). No activated sporozoites were observed in intact oocysts collected from the crops, gizzards, or intestines.

*In vitro* excystation of chicken and turkey coccidia—In tests lasting up to 5 hours, all attempts to bring about excystation of sporozoites from intact oocysts were unsuccessful. Exposure of mechanically released sporocysts to various pancreatic preparations resulted in a small percentage of excystation. When bile or bile salts were combined with the pancreatic preparations the percentage of excystation was greatly enhanced. At pH 7.3 - 7.6, 0.25 percent trypsin 1-300 in 5 percent bile produced a large percentage of excystation from sporocysts of all 4 species tested. The sporozoites of the 2 cecal species excysted less quickly and survived longer in the excystation fluid than the sporozoites of the 2 duodenal species.

## GROSS MORPHOLOGY OF THE VIRGINIA I POPULATION OF THE STING NEMATODE

Betty J. Gray, *Virginia Agricultural Experiment Station*

Lawrence I. Miller, *Virginia Agricultural Experiment Station*

The gross morphology of a Virginia population of the sting nematode, *Belonolaimus* sp., indicates that it differs from the two described species, *B. gracilis* and *B. longicaudatus*.

The average, minimum and maximum dimensions of 30 adult female sting nematodes, collected July 7, 1958, from around corn roots on the J. F. Worrell farm near Kingsfork, Virginia, (designated as the Va. 1 population) were as follows: L=2.2 mm. (1.8-2.6); c=14.5 (11.8-19.6); V=50.3 (43.7-57.7); S (stylet)=141.9 microns (118.4-151.3); length from tip of stylet to guide ring=102.8 microns (79.0-111.9); T=155.1 microns (108.6-181.0); T/anal width=4.9 (3.5-6.1); S/T=0.92 (0.77-1.24); index number  $[A \text{ (length anterior to vulva)} / P \text{ (length posterior to vulva)}] \div S/T = 1.1$ . The median bulb of the females is slightly elongated and the tail tip is convex conoid. The dimensions of 30 adult males collected as above were as follows: L=1.9 mm. (1.6-2.3); c=13.6 (11.3-16.5); S=126.8 microns (111.9-138.2); length from tip



of stylet to guide ring=92.3 microns (80.0–102.0);  $T=138.1$  microns (105.3–157.9);  $S/T=0.92$  (0.77–1.28); spicule length along the chord =49.0 microns (42.8–55.9). The median bulb of the males is elongated.

*B. gracilis* is distinguished from the Va. 1 population of the sting nematode by the spherical median bulb, the  $S/T$  ratio and the index number derived from  $A/P \div S/T$  of the females. *B. longicaudatus* is distinguished from the Va. 1 population of the sting nematode by the presence of an opposing pair of sclerotized pieces in the vagina and the hemispherical shape of the female tail tip.

## RESISTANCE TO INSECTICIDES IN VIRGINIA

James McD. Grayson, *Department of Entomology, V.P.I.*

Resistance to insecticides in 15 species of arthropods attacking agricultural crops, and three species affecting animals, is reported. Types of resistance, cross resistance, and stability of resistance are briefly discussed. Some solutions to the resistance problem are presented.

## ADAPTATION OF COASTAL AND MIDLAND BERMUDAGRASS IN SOUTHEASTERN VIRGINIA

D. L. Hallock, *Virginia Agricultural Experiment Station*

The adaptation and productivity of coastal and Midland Bermudagrass was compared to Ky. 31 fescue in a test initiated in 1960 at the Tidewater Research Station, Holland. Also, the effect of rye overseeded in Midland Bermudagrass during the winter season was studied. Nitrogen at rates of 100, 200, 400 and 800 pounds per acre, annually, was applied in 5 increments proportional to the production of the forages. Liberal amounts of K and P were applied in February. The experiment was located on an excessively drained Ruston loamy fine sand. Two years' results are summarized.

The Bermudagrasses produced approximately twice as much forage as Ky. 31 fescue. Yields of all forages were doubled by the application of 800 as compared to 100 pounds per acre of N, although the yields were nearly as high from plots getting the 400 pound rate. Coastal outyielded the other forages at all except the 800 pound level of N. In that case, the Midland + rye combination produced 8.3 tons to 7.8 tons for coastal. Coastal Bermudagrass was somewhat more responsive to N than Midland. Yields of rye hay on the higher N plots were approximately 1 ton per acre. Under the high rates of N, coastal Bermudagrass produced about 1 ton per acre of crude protein and removed 300 pounds of K from the soil

## MAKING USE OF ELECTRONIC COMPUTER EQUIPMENT TO EVALUATE FERTILIZER MANUFACTURERS IN CONTROL PROGRAM

Arthur T. Hart, *Virginia Department of Agriculture, Richmond*

It is now possible to predict the percent of plant food deficiencies that will occur in a given fertilizer by programming past sample results through electronic computers. Such predictions are based on past methods, materials and formulations; any variation in manufacture will tend to alter results. One can achieve manually the same end result as the computer by using statistical formulas; however, the possibility of human errors and the time factors are great. This data is computed for each element in each grade and is used by the Department to plan and supervise the fertilizer inspection program and is furnished each registrant for their study and other use. The average analysis, the degree of variability, and the predicted range in which approximately 70% of the future sample results will fall are included in this report. With this information available, the manufacturer can foresee possible trouble spots and has the opportunity to alter his plans if he sees fit. The Department of Agriculture plans to expand this program in an attempt to work more closely with industry toward quality controlled production.

## LIME OR FERTILIZER FOR ALFALFA — WHICH IS CRITICAL?

W. W. Moschler, *Virginia Polytechnic Institute*

Alfalfa responds nicely to either lime or mineral fertilizer. There is no interaction between the two and the combined effects are simply additive. On a short term basis (one to three years) either amendment will substantially substitute for the other in terms of yield, provided the rates of application are relatively high. For longevity of the stand (four to eight years), lime becomes the more critical of the two.

## OBSERVATIONS ON BODY WEIGHT AND SURFACE AREA IN *Gallus domesticus*

A. T. Leighton, Jr., P. B. Siegel and H. S. Siegel, *Department of Poultry Husbandry, Virginia Polytechnic Institute*

The study presented was designed to obtain information on body weight and surface area of the domestic fowl from one-day old to 37 weeks of age. A highly significant quadratic regression equation using surface

area in square centimeters on body weight in grams was obtained for males and females separately. The equations were:

$$(1) \text{ Males } \hat{Y} = 47.760301 + .981548 X - .000098 X^2$$

$$(2) \text{ Females } \hat{Y} = 73.816642 + .929981 X - .000106 X^2$$

For accurate calculations of surface area in birds weighing in excess of 1000 grams it is essential to use six digits beyond the decimal point. Estimates on surface area utilizing the above regression equations were compared with the calculated surface area obtained from the formula — Surface area in  $\text{cm}^2 = 10 w^{2/3}$  where  $w$  = weight in grams and  $10$  = constant commonly utilized for birds. The differences in estimating the surface area by the two methods were highly significant ( $p < .01$ ) for both males and females. The data presented suggest that the regression equations obtained for males and females of different body weights were reliable estimates of surface area in the birds utilized in this study.

#### THE PLACE OF THE LOGARITHMIC SPRAYER IN AGRICULTURAL RESEARCH

H. M. LeBaron, *Virginia Truck Experiment Station*

The logarithmic or variable dosage sprayer is becoming established experimental equipment for research with agricultural spray chemicals. While the technique has been applied in various fields, it has proved to be especially useful in the evaluation of herbicides.

By using the logarithmic sprayer, an infinite number of rates in a logarithmic progression produces the whole dosage response spectrum in the field. These studies have led to the more accurate measurement of the selectivity factor, the optimum rate, and other specific criteria by which the practical value of a herbicide for a certain crop-weed combination can be assessed. The "dynamic" aspects of the herbicide application, such as interactions between rate, time, plant recovery, and disappearance of a herbicide from the soil can also be easily followed.

The log sprayer may also be used for more complex problems, many of which would be prohibitive by conventional plot work because of space, time, labor, and chemical that would be necessary. Two similar materials can be compared in one test by keeping the combined rate constant but varying the proportions of each inversely. More complex mixtures can be studied by holding one herbicide constant while varying another. Additives such as surfactants, oils, etc. may be varied while the herbicide is held constant.



## PHYSIOLOGICAL ASPECTS OF QUACKGRASS CONTROL

H. M. LeBaron, *Virginia Truck Experiment Station*

An investigation was conducted to determine the effects of various chemical and cultural treatments on the carbohydrate reserves and growth of quackgrass rhizomes, and the relationships between the control of quackgrass topgrowth and the effects on the underground organs.

All treatments had a marked effect on the carbohydrate content and yield of quackgrass rhizomes during some period of the growing season.

Of the cultural treatments, the spring plowing resulted in the most rapid decline in both yield of rhizomes and total carbohydrate. As soon as new topgrowth developed, however, the carbohydrates were gradually restored and the growth of new rhizomes was stimulated. Repeated cultivation throughout the season resulted in continuous and severe reductions of rhizomes and carbohydrates.

Applications of nitrogen prior to cultivation or herbicide applications tended to enhance the effectiveness of treatment on control of topgrowth, but this was often short lived.

The herbicides differed considerably in the rate and degree of reductions in rhizome yields and carbohydrates. They also varied greatly in the relationship between their effect on underground organs and topgrowth response.

Interactions between the cultural and chemical treatments were observed at all sampling periods. The herbicides, listed in the order of their dependency upon cultivation for effective control, were as follows: dalapon, fenac, amitrol-T, simazine, and atrazine.

## BLOOD VESSELS IN FETAL AND POSTNATAL SKINS OF GOAT AND SHEEP

Lubow A. Margolena, *Sheep and Fur Animal Research Branch, Animal Husbandry Research Division, ARS United States Department of Agriculture, Beltsville*

Development and distribution of blood vessels have been followed through the skins of fetal and postnatal goats and sheep. Irrespective of the type of coat produced and density of follicular population, the general pattern consists of three layers.

Follicular initiation in the common American, Toggenburg and Angora goats, and Karakul sheep, showed no direct contact with blood. Capillary supply to the dermal papillae, and capillary nets about follicles, or

capillaries running along smaller follicles all appear only after a certain degree of development has been reached. This also includes penetration to certain skin levels and production of follicular bulbs large enough to accommodate dermal papillae as well as capillary loops.

The direct supply of the primaries (earliest developing follicles) takes place between the 90th and 100th day of fetal life in dairy goats and Karakul sheep. Direct entry in the Angora begins first from the 100th day. Direct capillary supply preceded keratinization.

In the skins of goats and sheep the large blood vessels appear to branch into smaller units, including the capillaries, in immediate response to the demands of a follicular population. The follicles themselves seem to determine just when and where to attract the incoming and outgoing flow of blood.

#### A TRIAL USE OF SALT WATER RIVER SEDIMENT AS A MULCH ON SOME VEGETABLE AND ORNAMENTAL PLANTS

M. M. Parker, *Virginia Truck Experiment Station, Norfolk*

Sedimentary material, dug from the bottom of a shallow salt water river cove close to a bay, was air dried, broken into pieces and screened into small parts. It was then applied as a covering about one-half inch thick on vegetable seed and small ornamental and vegetable plants sown and set in ordinary field soil. The ground was covered with the mulching material immediately after sowing the seed or setting the plant.

Almost perfect weed control was obtained wherever the mulch was applied either to seed or plant, and it remained effective over a period of months. During that time the mulch remained loose and open, permitting ready entrance of water.

Plant growth, except in the case of azaleas and possibly camellias, was considerably better where the mulch was used.

Seed, planted during the heat and dryness of mid-summer, germinated quickly and effectively in soils covered with the mulch.

The material used in this test analyzed high in calcium, very high in magnesium, medium in phosphorus and very high in potash. It had a salt content of about 5000 ppm, a pH reading of 4.0 and an organic matter content of 7 percent.

DESCRIPTION OF LESIONS CAUSED BY LARVAE OF *Ascaridia columbae* IN  
THE LIVERS OF PIGEONS

W. T. Shalkop and Everett E. Wehr, *Beltsville Parasitological Laboratory,  
Animal Disease and Parasite Research Division, ARS  
U. S. Department of Agriculture, Beltsville*

In connection with studies on life history of the intestinal roundworm, *Ascaridia columbae*, of the domestic and wild pigeon, numerous small, pinhead sized lesions were observed on the surface of the livers of a few of the birds at necropsy. Each of these birds had received approximately 4,000 to 5,000 embryonated eggs of this nematode in successive doses over a 6 to 17 day period. These birds were killed and examined periodically from 21 to 92 days after the first inoculation and 3 to 76 days after the last. Portions of the livers were preserved in 10 percent neutral formalin solution, and later sectioned and stained in haemotoxylin-eosin stain for study.

An examination of these sections showed the lesions to have a generalized distribution throughout the liver tissue. They were of the multiple granuloma type and had arisen as a response of the host to the presence of the larvae which elicited this typical foreign body reaction. Large multinucleated giant cells of the foreign body type characterized these lesions and focal accumulations of eosinophiles and lymphoid cells were interspersed between the granulomas.

The progression of these lesions coincided with development of the degenerative changes in the parasite. In the areas surrounding the viable larvae, no host cell infiltration had yet occurred; however, both lymphoid cells and eosinophiles had begun to infiltrate those areas in which partially fragmented or degenerated larvae were found. As the lesions progressed the eosinophils became more prominent and, in many cases, were intimately associated with fragments of the parasites. Later these accumulations of eosinophiles became incorporated with necrotic debris in foreign body giant cell formations.

LIGHT MANAGEMENT FOR COMMERCIAL LAYERS

H. S. Siegel and W. L. Beane, *Virginia Polytechnic Institute*

Two experiments were performed in which commercial egg producing strains were maintained under two different artificial lighting regimes: (1) Six hours of daily light until 20 weeks of age and 3% weekly increments thereafter; (2) Fourteen hours of daily light until the 30th week of production (50 weeks of age), then continued on concurrent 3% weekly



increases with the 6 hour — 3% group.

It was found that age at first egg and 50% production were retarded when birds were restricted to 6 hours of light per day during the growing period. If, however, restricted light groups were given a 36-hour period of continuous light at 14 weeks of age, age at first egg was not significantly later than the 14-hour groups, although age at 50% production was retarded. There was no significant difference in egg production between groups for the 52 weeks as a whole, but a significant treatment x age interaction indicated treatment differences at various ages. Significantly less feed was required to produce a dozen eggs in the 6-hour — 3% groups. This difference could apparently be explained by the significantly smaller eggs and lower body weights in groups grown and maintained under restricted light.

#### THE QUANTITATIVE INHERITANCE OF 8-WEEK BREAST ANGLE IN *GALLUS DOMESTICUS*

P. B. Siegel, *Poultry Department, Virginia Polytechnic Institute*

An experiment was conducted to measure the short-term response of artificial selection for breast angle at 8 weeks of age in White Plymouth Rock chickens. Data, obtained from 5 generations of individual phenotypic selection in opposite directions, were used to determine heritabilities, types of gene action and sexual dimorphism for the trait under study.

Sexual dimorphism with males having significantly broader breast angles than females were found in all comparisons. Approximately 30 per cent of the total variation appeared to be due to hereditary influence. The rapid consistent separation of the lines in response to selection in divergent directions for breast angle suggested that a considerable amount of the genetic variation was additive. Comparisons of heritability estimates and reciprocal crosses between selected lines indicated further that practically all of the genetic variation could be accounted for by additive autosomal and additive sex-linked genic effects. Dominance, epistatic and maternal influences appeared to have minor roles in the inheritance of this characteristic.

#### SURVIVAL OF THE CYSTS OF *HETERODERA GLYCINES* ADHERING TO STORED SWEETPOTATO, PEANUT, AND PEANUT HAY

Grover C. Smart, Jr. and Barbara A. Wright, *Virginia Agricultural Experiment Station*

Quarantine regulations were established in Virginia in 1959 to prevent

the dissemination of the soybean cyst nematode, *Heterodera glycines*. It was, therefore, important to determine whether the contents (larvae and eggs) of cysts adhering to plant parts directly or in soil particles survive the normal curing and storing of certain farm products. Viable cysts were artificially affixed to freshly dug sweetpotato and to field-cured peanut fruit and peanut hay. (It has previously been reported that cyst contents remain viable during field and artificial curing of peanut fruit and hay). Other cysts, either mixed with soil or free of soil in Petri dishes, were placed with each plant product. The sweetpotatoes were cured and stored with the farmer's crop in two separate curing houses. The temperature and relative humidity during a 12-month period in one sweetpotato house varied from 46-98° F and 30-100%, and in the other house from 48-87° F and 37-94%. Peanut fruit and peanut hay were stored in a round metal storage bin. The temperature and relative humidity in the bin varied from 6-113° F and 12-100%. Cyst contents were viable after 12 months storage under all test conditions. Therefore, cyst contents remain viable longer than the normal curing and storing of sweetpotato, peanut, and peanut hay.

#### ANION RETENTION BY VIRGINIA SOILS

Grant W. Thomas, *Virginia Agricultural Experiment Station*

Studies of chloride, nitrate and sulfate retention by a number of Virginia soils suggest that clay mineral species, pH and iron oxide content are closely related to the amounts of anions adsorbed from salt solutions. Distribution coefficients, calculated at pH values ranging from 2 to 6, show that chloride and nitrate are held with about the same affinity; whereas, sulfate is held much more tightly. Determinations of native anions in acid, red subsoils indicate that sulfate can accumulate to the extent of several milliequivalents per 100 gm. of soil.

#### PROBLEMS IN STANDARDIZATION OF AN EMPIRICAL PROCEDURE FOR TOTAL NITROGEN AGAINST THE OFFICIAL KJELDAHL PROCEDURE

N. R. Thompson and W. K. Stone, *Virginia Agricultural Experiment Station, Blacksburg*

It may be desirable, for reasons of cost, time, etc., to adopt or develop an empirical analytical procedure and employ it routinely in chemical analyses. Such a procedure should be examined for precision and accuracy, which usually includes comparison with a standard or officially approved method. Two of the problems which arose, in standardization of a rapid method for nitrogen in whole milk, were (a) whether to dis-

card or retain extreme values and (b) how to determine the relationship between results by the rapid method and the standard method. A statistical test for outlying values showed that all extreme values were well within the normal range of results by the rapid method. Yields of nitrogen by the rapid method (which constituted about one-eighth of the total nitrogen present) were compared with those by the official method. Similar prediction equations for total nitrogen were obtained by two different statistical procedures.

#### MACHINE MONOLITHS SHOW WHY SOILS ARE DIFFERENT

George C. Willson, Jr. and Earl H. Brunger, *Soil Conservation Service*

This paper sets forth possible uses of the new style soil monoliths being made by the Soil Conservation Service through use of a soil coring machine. These 1" and 2" monoliths are easily and quickly prepared, light in weight, compact, and easy to transport. They are good visual aids to assist the public in becoming more soil conscious, and more aware of soil differences.

Several colored slides show exhibits of these monoliths illustrating soil development, soil catenas, erosion classes, pasture capacities, forest site indices, and suitability for septic tanks. Another exhibit shows predicted yields of corn and alfalfa under good management on seven different soil types, characteristics of which are shown by machine monoliths attached to the exhibit. Similar comparisons can be shown for other crops on other soil types.

The above are only a few examples of uses which may be made of machine monoliths in teaching or lecturing, or as stationary displays. It is hoped that wide use may be made of these monoliths and that many new individual displays and interpretations will be developed.

#### GENERAL REVIEW OF RELATIONSHIPS BETWEEN PASTURES AND PARASITISM IN CATTLE

H. H. Vegors, *Beltsville Parasitological Laboratory, Animal Disease and Parasite Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville*

Two important factors that influence nematode parasitism in grazing cattle are the animals' resistance to parasites and parasitic disease and the environment, such as pastures and climate.

The resistance of cattle to the establishment of parasites gradually de-



velops over many months through the gradual acquisition of infective worm larvae. However, overstocking of pastures may lead to the breakdown of this resistance. The nutrition furnished by pastures influences the development of immunity to the effects of parasitism. Resistance of a level sufficient to inhibit the growth of the worms but not strong enough to expel them from the host complicates control, either by drag therapy or by management methods.

The environmental factors of climate and season of year are not controllable. However, the interrelated factors of pasture and animal management can be altered to help control parasitic disease. Among the management practice that will be considered are grain supplements to grazing cattle, rate of stocking, and low-level chemical medication to reduce pasture contamination. To achieve a balance between high production per acre and the control of parasitism demands continuing surveillance and good management.

#### NUTRITIVE VALUE OF KELP MEAL FOR THE GROWING CHICK

E. L. Wisman and C. E. Howes, *Department of Poultry Science, V.P.I.*

Chicks reared in battery cages with wire floors did not respond with increased growth to 4 or 8 weeks of age when 2 to 6.5% Norwegian kelp meal was added to a ration complete in all nutrients known to be required for maximum growth. Chicks reared on litter averaged 3.78 lbs. in body weight at 9 weeks of age when 2% Norwegian kelp meal was added to the ration and 3.68 lbs. on the basal ration. The 0.1 lb. increase, however, only approached statistical significance. The addition of fish solubles or Erythromycin to the basal ration gave a significant growth response. This observation, along with the absence of a kelp meal response, indicated that the kelp meal did not provide any unidentified growth factor activity, which was attributed to the fish solubles response, or any antibiotic-like activity.

The kelp meal was found to contain 10% NaCl equivalent and 30 PPM manganese by chemical assay. When the salt was omitted from the basal, levels of kelp meal up to 8% still did not elicit a growth response. Adequate salt was supplied by 6.5% kelp meal. Two experiments indicated that the kelp meal spared manganese in a suboptimal manganese ration. However, the concentration of manganese found in the product was not sufficient to account for the sparing action.

## SECTION OF ASTRONOMY, MATHEMATICS AND PHYSICS

R. E. Garrett, *Chairman*B. W. Sloope, *Secretary*Miss I. Boggs, *Historian*D. Rae Carpenter, *Section Editor*E. F. Turner, *Council Representative*

## MINUTES

The business meeting was opened with general announcements by the Chairman, R. E. Garrett. The Secretary reminded the section members to return the postcards to the Academy membership committee so that the section roster would be up to date. Concerning inquiries about the early date at which the papers were called for, the Secretary pointed out that this date was set by the Editor of the Journal and was determined by printing schedules. However, more time had been requested in the future if at all possible. Dr. Robeson, VPI, asked if the section could not forego publication of titles and print a mimeographed program for the section several weeks before the annual meeting so that more time would be available for graduate students to submit papers. After some discussion, E. F. Turner, Council Representative, said he would bring this up at the Council meeting. Dr. Turner also mentioned the desire of keeping the History of the section up to date.

The Chairman called for the report of the nominating committee which consisted of Dr. A. D. Campbell, Dr. T. Gilmer, and Dr. A. Robeson. Dr. Campbell presented the recommendations of the committee for the Officers for the year 1962-63 as follows:

Chairman: B. W. Sloope, Virginia Institute for Scientific Research

Secretary: Tom Joyner, Hampden-Sydney

Council Representative: E. F. Turner, Jr., Washington and Lee

Section Editor: D. Rae Carpenter, Jr., Virginia Military Institute

Historian: Miss Isabel Boggs, Randolph-Macon Women's College

It was moved, seconded and passed that these recommendations be accepted. There being no nominations from the floor, the above slate of officers was elected unanimously.

Billy W. Sloope, Secretary

## RESONANCE ESCAPE PROBABILITY IN THORIUM NITRATE SOLUTIONS\*

L. S. Anthony and A. Robeson, *Virginia Polytechnic Institute*

Absorbers are introduced into an aluminum box in aqueous solution.

Neutrons from the V.P.I. Cockcroft-Walton accelerator produced by the d,d reaction are used. The neutron density in the system decreases with increasing absorber concentration from its initial value in a system of pure water due to scattering and absorption with the thorium, nitrogen, and oxygen added as thorium nitrate. In order to compensate for the effect of the nitrogen, oxygen and the non-resonant absorption of thorium, a "mock solution" was made in which the heavy absorber was iron.

The resonance escape probability is:

$$P(r)_{\text{TH}} = \frac{q_{\text{Th}}}{q_{\text{Fe}}}$$

where:  $P_{\text{Th}}$  = Resonance non-absorption probability in thorium nitrate

$q_{\text{Th}}$  = Slowing down density in thorium nitrate at some lethargy

$q$  = Slowing down density in ferric nitrate at the same lethargy

The resonance escape probability is then given by the ratio of counting rates of equivalent solutions measured with a bare  $\text{BF}_3$  detector.

Agreement with Monte Carlo predictions is within one per cent over concentrations from  $0 - 1 \times 10^{21}$  atoms of thorium per  $\text{cm}^3$ . The values for the resonance escape probability range from 100 to 96 per cent in these concentrations.

\*Supported by the United States Atomic Energy Commission

## THE MEASUREMENT OF PARTIAL SPECIFIC VOLUMES WITH THE MAGNETIC BALANCE

J. W. Beams and A. M. Clarke, *University of Virginia*

A modification of the magnetic suspension balance is described for the determination of densities and partial specific volumes of solutions of which only a small amount is available. Using only 200 microliters of solution, this balance is capable of measuring densities to a precision of better than 4 parts in ten thousand. This precision, and the small amount of solution necessary for the measurement, allow the computation of the partial specific volumes of ribonuclease and some viruses to a precision which has been quite difficult to obtain heretofore using the standard pycnometer technique.



## ACTIVATION ANALYSIS OF FISHBONE SAMPLE

Edward T. Bird, *University of Florida*, and Robert R. Slocum, *Norfolk College of William and Mary*

One of the authors, Dr. Bird, is doing work on the effects of trace elements on growth of rachitic rat tissue. Since activation analysis has become a sensitive method of detection of trace amounts of isotopes, it was decided to activate a bone sample to learn the technique.

The sample was irradiated in the experimental reactor at Oak Ridge National Laboratories in a neutron flux of  $10^{12}/\text{cm}^2/\text{sec}$  for a period of one hour. The sample was then dissolved in HCl and half-life studies and beta energy determinations made with a G-M Counter on an aliquot. The remainder of the sample was chemically separated on anion and cation exchange columns. These separated samples were then scanned repeatedly for a week on a single-channel gamma spectrometer employing a two inch diameter thallium activated NaI crystal as detector. The following isotopes were detected: Cl-38, Mn-56, Na-24, Cu-64, and a long-lived component, Ba-131, with a half-life of 11.5 days.

## LEAST SQUARE ANALYSIS RELEVANT TO RADIO ASTRONOMY

C. M. Bowden, *University of Richmond*

An exact least square solution for the parameters of a sine curve was obtained. The simplified solution for the curve

$$Y_i = a \sin (\chi_i + \Phi)$$

was given as:

$$\tan \Phi = \left( \frac{\sum_i Y_i \cos \chi_i}{\sum_i Y_i \sin \chi_i} \right) \left( \frac{\sum_i \sin^2 \chi_i}{\sum_i \cos^2 \chi_i} \right)$$

$$a^2 = \frac{(\sum_i Y_i \cos \chi_i)^2}{(\sum_i \cos^2 \chi_i)^2} + \frac{(\sum_i Y_i \sin \chi_i)^2}{(\sum_i \sin^2 \chi_i)^2}$$

It is shown that the least square sine curve solution to the points for a given frequency yields the Fourier component associated with that frequency.

An exact least square solution to a Gaussian curve was also given where the width at half maximum amplitude is known. For the curve

$$Y^i = Ae^{h(\chi_i - m)^2}$$

the parameters A and m are the following:

$$m = \frac{\sum_i \chi_i^2}{\sum_i \chi_i} - \left[ \frac{(\sum_i \chi_i^2)^2}{(\sum_i \chi_i)^2} - \frac{1}{\sum_i \chi_i} \left( \sum_i \chi_i^3 - \frac{W \sum_i \chi_i \log Y^i}{(N-1) \log 2} \right) \right]^{1/2}$$

$$\log A = \frac{1}{N} \left[ \sum_i \log Y_i + \frac{\log 2}{w} \sum_i (\chi_i - m)^2 \right]$$

Where  $2W$  is the width at half maximum amplitude and  $N$  is the number of measured quantities  $Y_i$ .

#### RADIOMETRIC MEASUREMENTS OF THE MOON AT 3.15 cm. WAVELENGTH

C. M. Bowden, *University of Richmond* and C. H. Mayer, *U. S. Naval Research Laboratory*

Radiometric measurements were made of the moon at 3.15 cm wavelength with the U. S. Naval Research Laboratory 50-foot antenna. The observations were conducted over a period of the lunation from May 3 to June 19, 1956. A least square sine curve fit to the measurements gives the following curve for the variation of the equivalent uniform disk brightness temperature with time:

$$T_e = (195 \pm 25) - (12 \pm 5) \cos (wt - 44 \pm 15) \text{ in degrees Kelvin.}$$

Further theoretical considerations dealing with a homogeneous substance for the moon give the following curve for the brightness temperature of the central point of the lunar disk based upon the least square curve for the equivalent uniform disk brightness temperature:

$$T_e = (200 \pm 25) - (20 \pm 5) \cos (wt - 44 \pm 15) ^\circ K$$

Also, from the theory and the value for the subsolar point surface temperature  $T_s$  taken from the infrared measurements, the dark side surface temperature,  $T_m$ , and the ratio of the thermal attenuation coefficient to the electromagnetic wave attenuation coefficient,  $\delta$ , are given as

$$T_s = 374^\circ K, \quad T_m = 110^\circ K, \quad \delta = 4.5$$

#### VHF OSCILLATIONS IN A PENNING GAUGE\*

R. N. Dennis, Jr., *College of William and Mary*

VHF oscillations with well defined frequencies have been observed

using a receiver connected to the anode of a Penning ion gauge. These oscillations seem to be associated with the slow wave modes of a plasma filled conducting cylinder. Slight variations in voltage cause abrupt changes in the gauge current concurrent with changes in the amplitude and breadth of observed resonances. This relation suggests that these slow waves may help to account for the gauge current. It appears that the slow wave modes are excited by a beam plasma interaction between electrons, oscillating between the cathodes in the electrostatic potential maximum, and the plasma.

\*Work supported by a grant from the National Aeronautics and Space Administration.

#### A SOLID STATE NEUTRON SPECTROMETER

G. T. Fairburn, W. B. Carpenter and A. Keith Furr, *Virginia Polytechnic Institute*

A fast neutron spectrometer, utilizing a silicon surface barrier diode as a detector of recoil protons knocked from a polyethylene film by a beam of incident neutrons, was designed and constructed. Pulses from the detector due to the electron-hole pairs created by the protons in the silicon are linear with respect to the proton energy and hence neutron energy. These pulses were fed to a multi-channel analyzer and used to obtain pulse height spectra from various neutron sources. These sources included the V.P.I. reactor, neutrons from the  $H^2(d,n)He^3$  reaction reaction using a Cockcroft-Walton accelerator and a small plutonium-beryllium source.

The spectrometer has an efficiency of approximately  $10^{-7}$  and an energy resolution of 10-15 per cent. The results using the Cockcroft-Walton accelerator source showed that the spectrometer could be used to investigate differential neutron cross-sections.

#### THE DETERMINATION OF THE MULTIPLICATION CONSTANT OF THE VMI SUB-CRITICAL REACTOR

W. D. Harris, G. C. Ridgely, Jr., C. R. Thomas, Jr.,  
*Virginia Military Institute*

The VMI sub-critical assembly is contained in a concrete tank, the top of which is at floor level. It is light water moderated and employs hollow natural uranium slugs supplied by the A.E.C. In the first determination of the multiplication factor, the common static method was used. Initial counts were made without fuel elements present and counts



were recorded as the lattice was filled to a full core of nine rows (217 fuel elements). The neutron amplification factor was calculated from the data recorded with a boron-trifluoride counter and the reciprocal of the amplification was plotted versus the number of fuel elements. From this plot the effective multiplication of the sub-critical was obtained.

In the second method a pulsed neutron generator is used to supply neutron bursts to the sub-critical lattice. A single channel time analyzer is used to obtain the prompt neutron decay curve. From this curve and a calculation of the geometric buckling, the prompt multiplication factor can be determined.

Initial data by the first method indicate that the multiplication factor is 0.71, a value considerably lower than desired. In the initial measurement, however, the detector was closer to the source than it should have been.

#### ANGULAR CORRELATION OF NEUTRONS AND GAMMA RAYS FROM THE $B^{11}(d,n)C^{12}$ REACTION

W. F. Huang and R. C. Ritter, *University of Virginia*

The  $B^{11}(d,n\gamma)C^{12}_{4.43}$  reaction was studied with 0.7- and 1.0-Mev incident deuteron energies. The targets were  $\approx 290$  and  $\approx 195 \mu\text{g}/\text{cm}^2$ , respectively, of enriched  $B^{11}$ , plated on tantalum backings. A 5" x 5" Ne 102 plastic scintillator was used for the neutron detector and a 1½" x 1" NaI (Tl) scintillator detected the  $\gamma$ -rays. A time-of-flight system, with a 0.9 meter flight path, provided energy discrimination of the neutrons, so that individual groups were observable. With the  $\gamma$ -detector located perpendicular to the reaction plane, the correlations with neutron angle are expected to approximate more conventional neutron angular distribution measurements. Within the fairly large quoted errors, we found this to be so. An interesting aspect of our "neutron angular distributions" is the large difference between the results at the two deuteron energies. The 1-Mev data shows strong forward peaking, similar to reported data at 2.65- and 5.35-Mev, but the 0.7-Mev data showed only a slight forward peaking. Angular correlations were measured with the  $\gamma$ -detector in the reaction plane. The data are being analyzed, and should provide information on details of the reaction mechanism.

#### POLARIZATION OF NEUTRONS FROM THE $Li^7(d,n)Be^8$ REACTION

F. L. Hereford and S. V. Topp, *University of Virginia*

Using a liquid helium neutron polarimeter, the polarization of the

ground state neutrons from the  $\text{Li}^7(\text{d},\text{n})\text{Be}^8$  reaction has been measured. Recoil alphas from neutrons scattered in a liquid helium scintillator (described in the preceding paper) were detected in coincidence with neutrons scattered to the right and left. Pulse height selection discriminated against lower energy neutron groups. The neutron polarization has been measured for various deuteron bombarding energies up to 1-Mev and as a function of scattering angle for 1-Mev deuterons. The neutron polarization reaches a maximum of  $-12 \pm 2\%$  (Basel Convention) at  $45^\circ$  c.m. for 1-Mev deuterons.

#### LEVELS IN $\text{Al}^{25}$ BELOW 7 MEV

W. T. Joyner, *Hampden-Sydney College*

The excitation function for the inelastic scattering of protons to the first level of  $\text{Mg}^{24}$  has been measured for bombarding energies between 2.7 Mev and 4.2 Mev, using an electrostatic accelerator. The 1.37 Mev gamma rays resulting from inelastic scattering were detected by a 2" x 2" cylindrical NaI scintillator at a laboratory angle of  $0^\circ$ . Six resonances occur in this energy interval, corresponding to levels in  $\text{Al}^{25}$  at excitation energies of 4.93, 5.09, 5.14, 5.75, 5.81, and 6.15 Mev. At each resonance, angular distribution measurements were made on both the 1.37 Mev gamma rays and the inelastically scattered protons. The nature of the distributions indicates compound nucleus formation at these energies, with no evidence of direct interaction effects.

#### USE OF SOLID STATE DETECTORS FOR PHOTONUCLEAR REACTIONS

W. R. Johnson and W. D. Whitehead, *University of Virginia*

A procedure for the fabrication of diffused junction silicon detectors has been developed which permits manufacture of counters 6 Mev thick for protons and with an energy resolution less than 1% for  $\alpha$  particles. Two of these detectors were connected so that the protons had to traverse both counters, and the pulses were summed so that the effective thickness was 10 Mev but the resolution was poorer. The summing counter was used to measure the energy distribution and angular distribution of protons from the  $\text{Al}_{27}(\gamma, \text{p})\text{Mg}_{26}$  reaction using 63 Mev bremsstrahlung spectrum from the synchrotron.

#### TIME RESOLUTION OF THE VERNIER CHRONOTRON

W. T. Joyner, *Hampden-Sydney College*

The vernier chronotron is an instrument designed to measure time inter-

vals on the order of nanoseconds ( $10^{-9}$  sec.). It consists of two circulation loops of coax cable, loop amplifiers, and associated circuitry. One of the loops is shorter by a fixed time increment than the other, so that one of the defining pulses gains on its companion pulse the fixed time increment each revolution. Eventually, the two are coincident and kill each other. The total time interval is the number of the revolutions multiplied by the time increment. (This circuit was designed by LeFevre and Russell.)

The output of the instrument was found to change about 5% for a change of input rate from 0 to 500 cps, or a relative channel shift of 10 channels in 200. This indicated that the chronotron should be used in fixed counting rate applications.

For three different loop circulation times three values of time resolution were found. At 1 mc/sec, the resolution was 4.5 ns. At 3.3 mc/sec, the resolution was 1.7 ns., and at 4 mc/sec, it was 1.5 ns. This resolution makes the instrument useful for positronium lifetime studies.

#### EQUILIBRIUM ULTRACENTRIFUGATION

H. G. Kim and F. N. Weber, Jr., *University of Virginia*

The equilibrium ultracentrifuge<sup>1</sup> has recently been used to study proteins, high polymers, and properties of solutions. Molecular weight determinations made with this centrifuge appear below in Table I. As seen from this data, the magnetically suspended centrifuge is operable over virtually all molecular weight ranging from  $10^2$  to  $10^6$ . Work recently completed on Bushy Stunt Virus<sup>2</sup> indicates the possibility of equilibrium

<i>Substance</i>	<i>C(gms/dC)</i>	<i>1-<math>\bar{V}_\rho</math></i>	<i>Mw</i>
Sucrose .....	3	.376	$341.6 \pm .6$
Insulin .....	.35	.261	$5,792 \pm 11$
Ribonuclease .....	.24	.302	$13,690 \pm 60$
Lysozyme .....	.2	.260	$14,800 \pm 70$
Fraction I .....	.1	.310	$2.80 \times 10^5 \pm 3 \times 10^3$
Polystyrene .....	.5	.286	$1.80 \times 10^5 \pm 10^3$
Bushy Stunt Virus .....	.13	.258	$7.80 \times 10^6 \pm 4 \times 10^4$

Table I

<sup>1</sup>Beams, J. W., Boyle, R. D., Hexner, P. E.; Rev. Sci. Instr. 32, 645 (1961).

<sup>2</sup>Mw= $7.8 \times 10^6$



determinations in the  $10^7$  region. Runs in this weight range are possible because of the inherent stability of the rotor at low speeds (e.g., 10 rps). Non-ideality studies of polymers at non-theta temperatures have been conducted. In the polystyrene-cyclohexane system, departures from ideality as a function of temperature and concentration were investigated.

#### ELECTRON MICROSCOPE STUDIES OF ELECTRODEPOSITION

Kenneth R. Lawless and Lucille B. Garmon, *University of Virginia*

Studies of the initial stages of electrodeposition were made by means of transmission electron microscopy. The single crystal films examined were prepared by electrodeposition of copper on thin films of electrodeposited nickel. Transmission electron micrographs revealed the presence of Moire fringes. The Moire patterns were analyzed to yield information concerning the manner in which electrodeposition of the first few atom layers occurs when one metal is plated onto a dissimilar metal.

#### ANGULAR DISTRIBUTION OF SATELLITE SCINTILLATION\*

J. D. Lawrence and J. E. Alexander, *College of William and Mary*

Strip chart plots of signal strength versus time for the 54 mc/s transmissions of artificial earth satellite 1961 Omicron 1 are examined for transits over Williamsburg, Virginia, in the period October, 1961, to April, 1962. The random fluctuations in signal amplitude due to irregularities in ionospheric ionization density are interpreted with respect to satellite position. Amplitude scintillations show a marked dependence on elevation angle and appear to decrease to a minimum for elevations greater than  $20^\circ$ . The nature of scintillation at high angles of elevation (small zenith distance) is not clear. Occurrence of scintillation as a function of satellite azimuth shows clear north-south asymmetries with a maximum centered near magnetic north. The magnitude of scintillation increases sharply for latitudes above  $40^\circ$  N. These results indicate that the fluctuations observed depend upon the length of the ionospheric part of the propagation path and probably upon the angle between the direction of propagation and the earth's magnetic field.

\*Work supported by a grant from the National Science Foundation.

#### SPACE VELOCITIES OF MIRA TYPE VARIABLES

V. Osvalds, *Leander McCormick Observatory, University of Virginia*

A. Marguerite Risley, *Randolph-Macon Woman's College*

Radial velocities by Merrill and proper motions derived by Alden and

Oswalds from McCormick and Yale plates were used to determine mean distances and absolute magnitudes of 345 variables. These variables were divided by periods into 8 groups of Mira stars, and a group of 26 carbon stars. Space velocities of 288 of these variables were found, 57 being excluded for lack of presently available radial velocities.

The significant feature of this paper is the homogeneous set of proper motions. In comparison with those from other sources the absolute magnitudes reveal acceptable agreement for variables with periods less than 300 days, but are about one magnitude brighter than those of other sources for periods greater than 300 days. An exception is Miczaika's compilation which agrees well with ours except for the longest periods.

Space velocities from our investigation indicate that Mira variables with periods less than 300 days more further from the galactic plane and in orbits of greater inclination than those with longer periods.

This work has been published in the Publications of the Leander McCormick Observatory, volume XI, (1961).

#### PULSED NEUTRON MEASUREMENTS IN WATER AND ICE\*

J. A. McClure and A. Robeson, *Virginia Polytechnic Institute*

A Cockcroft-Walton accelerator with a pulsed source has been used to study neutron diffusion parameters in  $H_2O$  as a function of temperature. The diffusion parameters ( $\Sigma_{av}$ ,  $D$  and  $C$ ) have been measured as a function of temperature below room temperature by determining buckling for different sizes of cylinders. The experimental arrangement permits measurement of samples above and below the freezing point.

Neutrons from the  $T^3(d, n)$  reaction were used and a large  $BF_3$  counter, located at a point of symmetry, was the detector. A multi-channel time analyzer was used to determine the time dependent, thermal neutron distributions.

\*Supported by U. S. Atomic Energy Commission.

#### PHOTONEUTRON CROSS SECTIONS OF LANTHANUM AND PRASEODYMIUM

L. B. Rice, L. N. Bolen, and W. D. Whitehead, *University of Virginia*

The effect of shell closure upon the photodisintegration giant resonance was investigated by measuring the  $(\gamma, n)$  cross sections of lanthanum and praseodymium using the bremsstrahlung from the 70 Mev electron synchrotron at the University of Virginia. The photoneutron yield points were measured, at .5 Mev intervals from 8 to 30 Mev, using the Halpern-

type detection system. The synchrotron beam was monitored by an ionization chamber calibrated to  $\pm 2\%$  by the National Bureau of Standards, also the neutron detection efficiency was calibrated by using a Ra-Be neutron source known to  $\pm 3\%$ . The yield curve was determined using the average of 24 independent determinations. The daily fluctuations in the yield points were less than  $\pm 2\%$ , and the uncertainties assigned to the yield points were computed from the standard deviation of the independent runs. The method of Penfold and Leiss was used to extract from the yield curves the total neutron cross section,

$$\sigma_{\mu} = \sigma(\gamma, n) + \sigma(\gamma, pn) + 2\sigma(\gamma, 2n) + \dots$$

The results show that the half width at half maximum cross section of lanthanum is less than that of praseodymium, being  $3.2 \pm .3$  and  $3.6 \pm .3$  Mev, respectively. It was possible to fit both cross sections, corrected for the multiplicity in  $\sigma(\gamma, 2n)$ , with a Lorentz curve. The maximum cross sections were  $304 \pm 15$  and  $305 \pm 15$  mb, occurring at  $14.5 \pm .3$  and  $14.8 \pm .3$  Mev, respectively for lanthanum and praseodymium.

#### COULOMB EXCITATION OF MEDIUM-LIGHT ODD-A NUCLEI

R. C. Ritter, *University of Virginia*

Ne<sup>20</sup> ions with energies of 8- to 15-Mev were used for Coulomb excitation studies of levels in medium-light odd-A nuclei. Doubly and triply charged Ne<sup>20</sup> ions were obtained in enhanced quantities from a PIG-type ion source, and accelerated in the Oak Ridge National Laboratory 5.5 Mev Van de Graaf. Heavy ions are able to provide electromagnetic excitation  $\gamma$ -ray yields and angular distributions which are generally freer of complexities than those obtained with protons and helium ions. This permitted a detailed study of the lower-lying levels of eight odd-A nuclei from Ti<sup>47</sup> to As<sup>75</sup>. The angular distribution measurements provided strong evidence for unique spin assignments for four of the levels which were excited. Two of these assignments (in Zn<sup>67</sup>) conflict with accepted values, and two of them confirm values previously accepted on weaker evidence. E2 matrix elements were determined for 14 transitions in the eight nuclei, and M1 matrix elements were determined for 10 transitions. Ten of the E2 matrix elements exhibited enhancements greater than 10 times, compared to single-particle estimates. The occurrence of such enhancements is not predicted at such low levels ( $\leq 300$  kev) for these nuclei, by the conventional vibrational collective model.

#### FORMATION CONDITIONS AND STRUCTURE OF THIN EPITAXIAL GE FILMS

B. W. Sloop and C. O. Tiller, *Virginia Institute for Scientific Research*

An experimental investigation of the effects of formation conditions on



the structural characteristics of thin Ge films vacuum deposited onto synthetic single crystals of  $\text{CaF}_2$ ,  $\text{MgO}$ , and  $\text{NaCl}$  is reported. Formation conditions include substrate temperature during deposition, rate of deposition, and heat treatment. The amorphous to crystalline transformation of Ge was found to occur in the 300-400° C substrate temperature range. It is shown that single-crystal films, 1500 Å thick, can be formed on  $\text{CaF}_2$  substrates at temperatures between 450° C and 700° C by proper choice of rate of deposition. Crystalline structure, porosity, complexity of imperfections, and film adhesion are dependent on the rate of deposition and deposition temperature.

#### THE ELECTRONIC PROPERTIES OF TELLURIUM AT HIGH PRESSURE AND AT LOW TEMPERATURE\*

Ralph E. Stajdohar and James N. Boyd, *University of Virginia*

We are in the process of measuring the Hall coefficient, magnetoresistance, and conductivity of pure tellurium at 77°K and 4.2°K as a function of pressure up to pressures of about 9000 atmospheres. At these low temperatures the conductivity and Hall coefficient for pure, extrinsic tellurium can be described by equations of the form

$$\sigma T^s = A + B e^{-\Delta E/KT}$$

$$RT^s = A' + B' e^{-\Delta E/KT}$$

where A, B, A', and B' are temperature independent and the exponent s depends on the kind of scattering. These equations are consistent with extrinsic conduction by two sets of holes, the fast hole band being separated from the slow hole band by an energy gap of  $\Delta E \approx 0.025$  ev. Theoretical studies indicate that this picture for the valence band is quite realistic. These studies further indicate that a large pressure dependence of this gap is to be expected and this experiment should add additional evidence as to the existence of the gap and its pressure dependence.

The paper being presented here describes the construction of the experimental apparatus and the experimental techniques for this kind of study. Slides will be shown.

\*Supported by the Army Research Office, Durham, N. C.

#### SOLID HELIUM AT HIGH PRESSURE\*

John W. Stewart, *University of Virginia*

In 1956, the author (1) measured the compressibility of solid  $\text{He}^4$  at

4°K at pressures up to 20,000 kg/cm<sup>2</sup>. The direct piston displacement technique was used. A comparison between this compressibility and that of the lighter isotope, He<sup>3</sup>, has great potential interest. Natural helium contains only about one part per million of He<sup>3</sup>, and it is only recently that sufficient He<sup>3</sup> has become available for such a comparison to be feasible. No other pair of stable isotopes differs so greatly in macroscopic physical properties. He<sup>4</sup> obeys Bose-Einstein statistics and has zero nuclear spin, while He<sup>3</sup> obeys Fermi-Dirac statistics and has nuclear spin 1/2. In addition, He<sup>3</sup> has somewhat higher zero point energy. It cannot be predicted at present whether, as one might suspect, He<sup>3</sup> has a significantly greater compressibility than He<sup>4</sup>. These factors may or may not work in the same direction. Measurements similar to those used earlier are now in progress on He<sup>3</sup>, but because of sealing difficulties, insufficient data to make a detailed comparison have been accumulated so far.

\*Supported by Army Research Office, Durham, N. C.

(1) J. W. Stewart, *J. Phys. Chem. Solids*, *1*, 146 (1956)

#### GAMMA-GAMMA ANGULAR CORRELATION IN Cs<sup>133</sup>

J. K. Sun and C. D. Bond, *Virginia Polytechnic Institute*

The angular correlation of the 356-82 Kev cascade in Cs<sup>133</sup> following the K - capture of Ba<sup>133</sup> has been investigated using a solid source of Ba(NO<sub>3</sub>)<sub>2</sub>. Spin assignment of the levels involved are given as 1/2 → 5/2 → 7/2 with the 82 Kev transition being a mixture of 96.5% M(1) and 3.5% E(2) radiation. Because of the rather long lifetime of the 82 Kev level of 6.0 x 10<sup>-9</sup> sec.), one might expect an attenuation of the asymmetry A ( $A = W(\pi)/W(\pi/2) = \text{anisotropy} + 1$ ) due to a possible quadrupole coupling with the electric field gradient at the site of the Ba<sup>133</sup> nucleus in a solid source. Previous angular correlation measurements using both liquid and solid sources of BaCl<sub>2</sub> agree with the spin assignment and also show no attenuation of A for the solid source. The present measurements using a solid source of Ba(NO<sub>3</sub>)<sub>2</sub> furnish a further check on these observations. The data are shown in the following table.

Observer	Source	State	$W(\pi)/W(\pi/2)$
Arya	BaCl <sub>2</sub>	Liquid	$1.062 \pm 0.007$
Clikeman and Stewart	BaCl <sub>2</sub>	Liquid	$1.053 \pm 0.010$
Observed	BaCl <sub>2</sub>	Solid	$1.040 \pm 0.010$
	Ba(NO <sub>3</sub> ) <sub>2</sub>	Solid	$1.043 \pm 0.014$

A LIQUID HELIUM SCINTILLATOR FOR MEASUREMENT OF NEUTRON  
POLARIZATIONS. V. Topp and F. L. Hereford, *University of Virginia*

A liquid helium scintillator has been constructed and used as a scintillating-scatterer of medium energy neutrons. Scintillations deriving from recoil alpha particles in the helium are counted in coincidence with scattered neutrons. The scintillator volume is defined by a polished aluminum can of 1" diameter and 2" length, the can being attached to the end of an 18" long quartz light pipe and immersed in liquid helium. Scintillations are detected by a quartz face RCA 6903 Photomultiplier optically coupled to the other end of the light pipe. In order to shift the extreme ultraviolet helium scintillations to longer wavelengths, the inner surface of the aluminum can is coated with sodium salicylate and a thin evaporated layer of p-quaterphenyl. The immersed end of the light pipe also carries a 50 micrograms/cm<sup>2</sup> thick layer of evaporated p-quaterphenyl. Under optimum conditions of operation, the pulse spectrum for 5.3-Mev alpha particles has a width at half maximum of 17%.

USE OF FAST COINCIDENCE TECHNIQUE TO MEASURE DYNAMIC MAGNETIC  
FIELDSWilliam A. Walker, Jr., *University of Virginia*

The magnetic guide field in a circular accelerator holds charged particles on roughly circular orbits. It is designed to focus the particles at the center of the aperture. Its structure is conveniently described by

$$B = B_0 \left( \frac{r_0}{r} \right)^n.$$

The dynamic magnetic guide field in the University of Virginia 70 Mev synchrotron has been measured at three times shortly after zero field in 200 locations. Using three biased peaking strips, values of B and n have been obtained at each location for the three times. The measurements have been fitted closely by several series of analytic functions.



## SECTION OF BACTERIOLOGY

Catherine M. Russell, *Chairman*H. T. Knighton, *Vice Chairman*Grace J. Blank, *Secretary*P. Arne Hansen, *Section Editor*

## MINUTES

The Virginia Branch of the American Society for Microbiology held its spring meeting in conjunction with the Virginia Academy of Science. The following were elected to office: Grace J. Blank, Chairman; Lilla C. Rucker, Vice Chairman; Gerald Goldstein, Secretary-Treasurer; and P. Arne Hansen, Section Editor.

Gerald Goldstein, *Secretary-Treasurer*

THE INCIDENCE OF DRUG RESISTANT MYCOBACTERIUM TUBERCULOSIS  
ISOLATED FROM 482 PATIENTS AND THE EFFECT OF RESISTANCE ON

## PROGNOSIS

Marvin J. Allison and Miles Hench, *Medical College of Virginia*

Sensitivity studies were done by the indirect method on 482 negro patients in the Sanatorium Division of the E. G. Williams Hospital in Richmond. A clinical evaluation was made simultaneously to determine the outcome of this disease.

237 cases (49%), had bacilli sensitive to all major drugs. In 86 cases (18%), bacilli were resistant to one drug; 98 cases (20%), had bacilli resistant to two major drugs. 13% or 61 cases had bacilli resistant to all three major drugs. Over the years from 1957 to 1960 the number of new cases admitted with resistant organisms has increased considerably. The clinical evaluation of our patients showed improvement in 57%, with 23% leaving the hospital against advice to serve as possible contacts for the dissemination of resistant organisms. Our studies show that a new case has twice as much chance to improve clinically as a case that has received previous treatment. Also among the new cases only 1 in 10 patients went into chronicity or died whereas among the cases that had been treated previously 4 out of 10 became chronic or died.

We conclude that in the negro, possibly due to his social and economic conditions in this country, the tubercle bacillus is more prone to develop resistance. The large numbers of new cases that are found resistant to all the major drugs point out our need for newer and better chemotherapeutic agents against the tubercle bacillus.

## FLUORESCENT INSULIN

G. Goldstein, M. L. Smith and D. R. Gourley, *University of Virginia  
School of Medicine*

Fluorescent insulin has been prepared at molar ratios of fluorescein isothiocyanate to insulin of 5:1 to 2:1. The unreacted fluorescent products were separated from fluorescent insulin by passage through Sephadex G-25 columns. The biological activity of these preparations as measured by the rat epididymal fat pad assay ranged from 9 to 25%. The binding of fluorescent insulin and human serum globulins was measured by incubating the two and passing the mixture through Sephadex G-75 columns. Bound fluorescent insulin emerges with the serum globulins at one column volume, while unbound fluorescent insulin emerges later. Competition between crystalline insulin and fluorescent insulin for binding by serum globulins was demonstrated.

THE IDENTITY OF *Lactobacillus bulgaricus*

Judith H. Kahn and P. Arne Hansen, *University of Maryland, College  
Park, Maryland*

The name, *Lactobacillus bulgaricus*, has currently been used for two different species resulting in confusion. One type produces only about 1.7% levo lactic acid (D configuration) in milk, while the other forms inactive lactic acid, and in a higher yield more than 2.3%. Orla-Jensen insisted that the levo lactic acid form only deserves the name *L. bulgaricus* (or *Thermobactericum bulgaricum*). Recent work by deMann on Dutch yogurt has reaffirmed this position.

A number of yogurt samples from eastern Europe were studied from which strains forming levo lactic acid with low final acidity were obtained conforming to the description of Orla-Jensen. The isolates were compared and agreed with the original type culture of this author.

THE DEMONSTRATION OF LYSOZYME AND ACID PHOSPHATASE IN THE  
SUBCELLULAR PARTICLES OF ALVEOLAR MACROPHAGES

Eva S. Leake and William B. Hunt, Jr., *University of Virginia  
School of Medicine*

Alveolar macrophages from normal and from BCG vaccinated rabbits were homogenized in 0.25 M sucrose and submitted to differential centrifugation. Four fractions were obtained: nuclear fraction, heavy mito-

ohnondria, light mitochondria and supernate containing possibly microsomes and the soluble material of the homogenate. Lysozyme and acid phosphatase determinations were carried out on aqueous extracts prepared from these fractions. The results obtained indicate that lysozyme is bound in sub-cellular particles residing primarily in what is presumed to be the heavy mitochondrial fraction. Acid phosphatase was more widely distributed among the fractions obtained.

#### THE EFFECT OF SELECTED SPECIES OF BACTERIA ON *Entamoeba histolytica*

E. Clifford Nelson and Muriel M. Jones, *Medical College of Virginia*

In an effort to simulate conditions in the natural environment more closely, the authors have devised procedures and media for the cultivation of *E. histolytica* in a CO<sub>2</sub>-bicarbonate buffer system. In the course of cultivation studies on a strain of *E. histolytica*, it was found that encystment ensued in certain cultures. A mixed bacterial flora was present in these cultures. Analysis of the flora showed that *Aerobacter aerogenes*, and species of *Flavobacterium*, *Streptococcus* and *Achromobacter* were present. The effect of these species on growth and encystment was observed in cultures inoculated with sterilized cysts or bacteria free trophozoites. All the species except the *Streptococcus* supported growth in the media used. Encystment occurred consistently with the *Flavobacterium*, to a lesser degree with a species of *Achromobacter* and sparsely with *Aerobacter aerogenes*. Encystment in monobacterial cultures has not been reported heretofore. Our success may be related to the use of the CO<sub>2</sub>-bicarbonate buffer system.

#### STUDIES OF HERPES NUTRITION IN CELL CULTURE

R. W. Tankersley, *Medical College of Virginia*

The importance of various amino acids to the synthesis of Herpes simplex virus in Minn-EE human cells was studied. Of those amino acids found in Eagle's basal medium, six were completely essential, only one was found to be nonessential, and three were present in a concentration that partially inhibits viral proliferation.

#### PATHWAY OF ASCORBIC ACID FERMENTATION IN *Aerobacter Aerogenes*

Wesley A. Volk, *University of Virginia School of Medicine*

A strain of *Aerobacter aerogenes* capable of carrying out an anaerobic decomposition of L-ascorbic acid was isolated by enrichment technique.



Enzyme studies have demonstrated that the pathway of this decomposition is as follows: ascorbic acid  $\rightarrow$  dehydroascorbic acid  $\rightarrow$  2,3 diketo-L-gulonic acid  $\rightarrow$   $\beta$ -keto-L-gulonic acid  $\rightarrow$   $\beta$ -keto-L-gulonic acid phosphate  $\rightarrow$  L-xylulose phosphate + CO<sub>2</sub>. Of the enzymes involved in this pathway, the enzyme catalyzing the reduction of 2,3 diketo-L-gulonate to  $\beta$ -keto-L-gulonate has been studied most extensively. This enzyme has been purified approximately 60 fold and the product of the enzymatic reduction has been isolated and identified by paper chromatography of the compounds formed by the NaBH<sub>4</sub> reduction of the  $\beta$ -keto acid. Characteristics of this enzyme, as well as other enzymes of this pathway, will be discussed.

#### HUMAN *Listeria monocytogenes* INFECTIONS IN VIRGINIA

H. J. Welshimer, *Department of Microbiology, Medical College of Virginia*

A report was presented of the human *Listeria* infections studied in Virginia since 1956. Twenty cases have been observed. Fourteen of these were infants and six were adults. All but three of the infections were meningeal in nature, from which *Listeria monocytogenes* was isolated from the spinal fluid. Isolations were made from the blood in two of the remaining cases and from the blood and vagina of one patient.

## SECTION OF BIOLOGY

W. L. Mengebier, *Chairman*

Dorothy Crandall, *Secretary*

J. C. Thompson, *Section Editor*

### MINUTES

The business meeting of the Biology Section was called to order by the chairman, Dr. William Mengebier who read a letter from W. C. Currutt, supervisor of the Thomas Jefferson National Forest thanking the Virginia Academy and other groups for their cooperation in the establishment of Mt. Rogers as a scenic area. Because of concern over the pending Jennings Bill and the possible effect this might have upon the present status of Mt. Rogers as a natural area, a motion was approved to inform the Natural Resources Committee of the Virginia Academy of Science that a further investigation of this bill is needed. It was recommended that the Lake Drummond Area of the Dismal Swamp be set aside as a natural area and that this motion be conveyed to the Natural Resources Committee.

It was approved that the nominating committee be responsible for all

nominations for the section. It was also suggested that the immediate past chairman of the Biology Section be a member of this nominating committee. The following officers were elected for the coming year: Chairman, Dr. Walter S. Flory Jr.; Secretary, Dr. Warwick West. Continuing in office are Council Representative, Dr. Harry G. Jopson and Section Editor, Dr. Jesse C. Thompson.

Dorothy L. Crandall, *Section Secretary*

#### INFECTIOUS DISEASE DAMAGES MID-ATLANTIC OYSTER POPULATION

Jay D. Andrews, *Va. Institute of Marine Science, Gloucester Point*

A protistan organism discovered by Haskin, Stauber, and Mackin (unpublished) decimated oyster populations in Delaware Bay (beginning in 1957) and Chesapeake Bay (beginning in 1959). The organism, called MSX, appears as multi-nucleated plasmodia in oysters. Death rates are high from June to November with minor losses in late winter. The patterns of mortality caused by MSX differ in intensity and timing from other known pathogens of oysters in the mid-Atlantic area — *Dermocystidium marinum* and *Haplosporidium costale*.

This apparently newly-introduced disease has almost stopped oyster culture in the high-salinity areas of Chesapeake and Delaware Bays. Prices of marketable oysters have risen sharply as production in these major producing areas has fallen. Seed supply has remained adequate because seed areas are in low-salinity waters. Large segments of the industry have been seriously damaged or forced out of business.

The organism is being monitored intensively for changes in distribution and activity in Chesapeake Bay. Strong emphasis is being placed upon a search for resistant races of oysters in nature and selection is being attempted in laboratory breeding programs.

#### SOME ECOLOGICAL STUDIES OF THE *Branchiobdellidae*

George Gordon Brown, *Department of Biology,  
Virginia Polytechnic Institute and University of Virginia*

Several anatomical and taxonomic studies dealing with numbers of the branchiobdellids have been done, but very little work has been done on the ecology of these worms. In this work, the author has attempted to show some quantitative relationships among six species of branchiobdellids.

The study was made in Sinking Creek, Giles and Craig Counties, Virginia. Only one, *Cambarus bartoni sciotensis*, of the two species of crayfish was collected. The six species of branchiobdellids found were *Cam-*

*barincola branchiophila*, *C. fallax*, *C. ingens*, *Pterodrilus alcicornus*, *Xironogiton instabilis*, and Species X. Species X was found only in the upper portion of the stream while *X. instabilis* was found only in the headwaters. The other species were found throughout the stream.

In the headwaters, all six species of branchiobdellids were found in greater abundance than at any other station. Since the crayfish population is also larger at this station, the author is suggesting that the number of worms is correlated with the number of crayfish.

The microhabitats of the species of branchiobdellids on the host were determined plus some aggregational tendencies and predation among the worms. Also seasonal collections were compared and differences were found to be small.

#### THE BIOLOGY OF THE VIRGINIA PINE SAWFLY, *Neodiprion Pratti Pratti* (DYAR)

Marvin L. Bobb, *Agricultural Experiment Station*, and C. L. Morris,  
*Division of Forestry, Charlottesville*

A serious outbreak of the Virginia pine sawfly began in 1957; and by 1959, more than two million acres of pine forest were infested. The sawfly passes the winter as eggs in the needles of pine trees. The eggs hatch in April, and the larvae feed on the needles of the previous season's growth. The mature larvae crawl to the ground, change into the prepupal stage, and spin cocoons in the litter on the forest floor. Pupation takes place in late September and the peak of adult emergence occurs in mid-November. Virginia pine was found to be the preferred host, but infestations frequently occurred in plantings of loblolly and short leaf pine. The average length of life of adults at a temperature of 45° F. was 12-1 days for the males and 11.7 days for the females. Each adult female matured an average of 66.4 eggs. Mated females oviposited 88.3 percent of her eggs; whereas unmated females oviposited only 19.7 percent, none of which hatched.

#### DETERMINATION OF OXYGEN IN WATER USING A 10 ML. SYRINGE

Jack D. Burke, *Department of Biology, University of Richmond*

In 1888, Winkler described a chemical method for determining dissolved oxygen in water samples. Alsterberg modified this method in 1925 so that nitrites, a common source of interference in most natural waters, were chemically eliminated. This modification has made the method a standard procedure for oxygen determination in water where large



samples were available. The procedure described here allows oxygen to be determined in a small sample of water using a 10 ml. syringe although maintaining the essential chemical entities described by Winkler and Alsterberg. Oxygen in water samples can be determined in less than ten minutes using this syringe technique within a 2% experimental error on duplicate analyses. The equipment and reagents are easily transported in a small container for field work, and all materials are readily procured from supply houses.

#### A SIMPLE TECHNIQUE FOR REMOVING FISH BLOOD

Jack D. Burke, *Department of Biology, University of Richmond*

A fish is immobilized on a board using barbless curtain hooks to pierce the lower jaw and caudal peduncle. The body is strapped down with cord tied to movable wire clips and fastened to eyelet hooks with both clips and hooks attached to opposite edges of the board. The heart is exposed by lifting the gills, easing through the posterior wall of the branchial chamber, and slitting the pericardium. Although the fish heart is small, averaging about 1/9 (per cent by body weight) the size of a mammal heart, blood from large fishes may be withdrawn via a syringe and needle rinsed with heparin (100 mg/15 ml of 0.11 M NaCl). In small fishes, the heart can be clipped and blood removed (by a 0.1 ml mouth pipette rinsed with heparin) as it "wells" into the pericardial cavity.

#### A SPECTROPHOTOMETRIC PROCEDURE FOR DETERMINATION OF OXYHEMOGLOBIN AFFINITY CURVES

Jack D. Burke and W. Allan Powell, *Department of Biology, University of Richmond*

Spectrophotometry has been found to be very helpful in the study of the affinity of hemoglobin for oxygen. The method involves the measurement of the change in absorbance of hemoglobin as a function of the pressure of oxygen above the hemoglobin. In the present modification the desired oxygen pressure is obtained by evacuating to reduce the pressure from atmospheric pressure to the desired lower pressure. Such a procedure for obtaining the desired pressure is much less time consuming and is much easier to perform than the alternate procedure of using a syringe for oxygen introduction.

Other modifications have been made in addition to that discussed above to give a method with good precision and which gives results in agreement with those obtained using other methods.

STUDIES OF THE GENITALIA OF SPIDERS OF THE SPIDER GENUS *Dolomedes*  
(*Pisauridae*)

James E. Carico, *Virginia Polytechnic Institute*

The internal structures of the copulatory systems of the female members of the genus *Dolomedes* are described. These structures are used as a basis for demonstrating natural subdivisions within the genus. A new species is also recognized on the basis of distinctive characters of the copulatory system.

SMALL MAMMAL POPULATIONS OF NATURAL AND DISTURBED PIEDMONT  
FORESTS

J. L. Chamberlain, *Department of Biology, R-M.W.C.*

From June, 1961, to May, 1962, small mammals were live-trapped and marked in natural forest areas and in an area drastically disturbed by a current forest management practice. Two hundred and twenty-four mammals were captured in 5854 trap-nights. *Peromyscus* was by far the most common species on all areas. Densities of *Peromyscus* ranged from 0.18 to 1.81 mice per acre in the natural areas, whereas on the disturbed site the density was 1.10 to 4.36 mice per acre. Annual fluctuations were similar on the mature and disturbed areas from a low level in April and May to a peak in late fall. Home ranges (exclusive boundary strip method) of 49 *Peromyscus* captured 3 or more times varied from 0.1 to 0.6 acres with a median at 0.3 acres.

THE GENUS *Calostoma* IN VIRGINIA

Mary Virginia Charlton, *Virginia Polytechnic Institute*

Little attention has been devoted to the fungi of Virginia, particularly to the fleshy Basidiomycetes. Occurring not infrequently among my collections during the last four years have been members of the genus *Calostoma* of the Order Gasteromycetales.

Three of the four species of *Calostoma* were collected in Virginia. *Calostoma cinnaborina* reported once for Virginia by Murrill, was collected in Rockbridge, Giles, and Montgomery Counties. *Calostoma lutescens* not previously reported from Virginia was collected in Buckingham and Montgomery Counties. *Calostoma ravenlii* not previously reported from Virginia was collected in Montgomery County.

## SOME VEGETATIONAL STUDIES OF NATURAL AND DISTURBED PIEDMONT FORESTS

Dorothy L. Crandall, *Randolph-Macon Woman's College*

In summer of 1961 certain quantitative and qualitative characteristics of the vegetation of three natural forested areas and a drastically disturbed area were investigated. The three forested communities, an oak, an oak-pine and a pine forest, are located on the Lee Forest in Buckingham County, Virginia and the disturbed area is located on private land in Appomattox County, Virginia. The disturbed area had been treated in 1960 by a combination of brush cutting, disking and burning and planted to loblolly pine in November, 1960. This disturbed area was the richest in number of species and coverage of herbaceous plants and in total number of stems of woody shrubs and vines. The number of species and coverage of herbaceous plants were the lowest in the oak forest. In the forested regions the greatest number of species and greatest number of stems of woody shrubs and vines were encountered in the oak-

## RESPIRATORY RESPONSE OF GERMINATING ASCOSPORES:

*Podospora anserina* NIESSLElizabeth Ann Davis and Eleanor Bowen, *Randolph-Macon Woman's College*

Tracer studies show that acetate-C<sup>14</sup> was incorporated into the dormant ascospore during the first 15 minutes of exposure to an ammonium acetate and glucose medium. Glucose-C<sup>14</sup> uptake occurred between 240 and 255 minutes.

Ascospores germinating on an ammonium acetate medium have an oxygen uptake at the endogenous level up to 120 minutes. It is postulated that during this period the acetate is simulating the production of adaptive enzymes for the glyoxylate cycle. There is a slight increase of oxygen uptake above the endogenous level from 120 to 255 minutes. After 255 minutes there is a sharp increase in oxygen uptake that is independent of glucose in the medium.

Germination of ascospores on ammonium tartrate and glucose was found to be inhibited by normal atmospheric carbon dioxide tension. Under reduced carbon dioxide tension data showed immediate uptake of oxygen which may be correlated with glucose incorporation. Under these conditions germination was found to be 59% as compared to 98% germination on ammonium acetate.



EFFECTS OF THYROIDAL DEPRESSION ON THE PITUITARY GLAND OF THE  
NEWT<sup>1</sup>J. N. Dent, *University of Virginia and Oak Ridge National Laboratory*<sup>2</sup>

Thyroidal depression is followed in many mammals by the development of large, chromophobic cells (thyroidectomy cells) in the pars distalis of the pituitary gland. Sustained thyroidal depression results, at least in the mouse, in the conversion of groups of thyroidectomy cells into tumorous growths (Halmi and Gude 1954). Similar cells begin to appear in the pars distalis of the newt, *Triturus viridescens viridescens*, 2 to 3 weeks after surgical or radiological thyroidectomy. Treatment of the newt with thiourea or potassium perchlorate brings on the development of thyroidectomy cells within 5 or 6 months. The newt seems to differ from the mouse in that sustained thyroidal depression has not produced pituitary tumors. Instead, some sort of adjustment has occurred resulting in the eventual disappearance of the thyroidectomy cells. Also, the thyroidectomy cell of the newt seems to develop from an acidophil rather than a basophil as in the mouse.

GEOGRAPHIC VARIATION IN THE CRAWFISH *Orconectes (Faxonella)*  
*clypeatus* HAYJ. F. Fitzpatrick, Jr., *Department of Biology, University of Virginia*

The crawfish *Orconectes (Faxonella) clypeatus* was subjected to a statistical analysis of geographical variation of morphological parts. All of the characters commonly used in crawfish taxonomy were studied. The common characteristic encountered was that, in general, *interpopulational* variation was within the limits of *intrapopulational* variation. However, slight East-West clines were evident in the length of the mesial process, width of the rostrum, and the ratio of the length of the basal portion of the first pleopod of males to the length of the central projection; and sexual dimorphism was seen in the distance between post-orbital spines, width of the palm, and length of the chela. Differences exist between first and second form males in length of pleopod, length of central projection, length of mesial process, and length of chela.

An examination of life history data gave no indication that there are significant differences in the life history across the geographic range. A sperm plug was not discovered in the annulus ventralis of any of the approximately 1500 females examined.

<sup>1</sup>Supported in part by AEC Contract AT-(40-1)-2000.<sup>2</sup>Operated by Union Carbide Corporation for the United States Atomic Energy Commission.

The crawfish seems to be limited in range to the coastal plain of the Gulf of Mexico and the Atlantic Ocean in the Southeastern States, occurring below the fall line. It is absent from the coastal marshes and peninsular Florida. The possibility of complementary geographic distribution between this species and the members of the *Barbatus* and *Plainirostris* Groups of the genus *Procambarus* was discussed.

This research was supported in part by a Grant-in-Aid of Research by the Society of Sigma Xi.

#### TAXONOMIC POSITION OF *Cooperia* HERBERT

R. O. Flagg and W. S. Flory, *The Blandy Experimental Farm*

Herbarium labels, correspondence and publications indicate that the classical treatment of *Cooperia* Herb. (1936) as a genus still prevails. The available artificial hybrids between *Cooperia* and *Zephyranthes* [*Cooperanthes* by Percy Lancaster (1913); *Z. (Cooperia) drummondii* Don x *pulchella* J. G. Smith by F. B. Jones (1957); (*Z. citrina* Baker x *rosea* Lindl.) x *Z. smallii* (Alex.) Traub (pro sp.) by T. Howard (unpub.)] set seed readily and have pollen stainabilities exceeding 90%. Recent studies indicate that several highly fertile taxa originally described as species (*C. smallii* Alex., *C. jonesii* Cory, and *Z. refugiensis* F. B. Jones) are natural hybrids between *Z. (Cooperia) herbertiana* Dietr. and *Z. pulchella*. We have also collected plants that are apparently natural hybrids of the formula (*Z. herbertiana* x *pulchella*) x *Z. (Cooperia) traubii* (Hayw.) Moldenke. The available data on breeding relationships and large populations of natural hybrids strongly supports the inclusion of *Cooperia* in *Zephyranthes* Herb. (1821) by Dietrich (1840), by Worsley (1928) and by a few later workers.

#### NOMENCLATURE OF *Zephyranthes pulchella* AND *Z. longifolia*

R. O. Flagg and W. S. Flory, *The Blandy Experimental Farm*

*Zephyranthes pulchella* and *Z. longifolia* are the only known yellow-flowered *Zephyranthes* species (excluding natural hybrid taxa) native to the U.S.A. Both species have short perianth-tubes and non-exserted stigmas. While *Z. pulchella* has short stigmatic lobes and occurs on the Texas costal plain, *Z. longifolia* has a deeply trifid stigma and is a high-lands species with a more westerly and more southerly distribution. Although *Z. aurea* Wats. (1883) has been treated as a synonym of *Z. longifolia* Hemsl. (1880), the specimen [Texas, *Plamer* 1303 (GH)] which might well serve as the type of *Z. aurea* is conspecific with *Z. pulchella* J. G. Smith (1895) [Type, Texas, *Nealley* s.n. (MO 140807)] *pulchella* has short stigmatic lobes and occurs on the Texas costal plain,

*Z. .lognifolia* has a deeply trifid stigma and is a highlands species with a more westerly and more southerly distribution. Although *Z.aurea* Wats (1883) has been treated as a synonym of *Z. longifolia* Hemsl. (1880), the specimen [Texas, Palmer 1303 (GH)] which might well serve as the type of *Z. aurea* is conspecific with *Z. pulchella* J. G. Smith (1895) Type, Texas, *Nealley s.n.* (MO 14807)<sup>1</sup>. On the other hand, in circumscribing *Z. aurea*, Watson also cited the syntypes of *Z. longifolia* Hemsl. [New Mexico, Wright 1904; Mexico, Parry & Palmer RG01], so that *Z. aurea* Wats. is an illegitimate name. *Zephyranthes longifolia* Hemsl. is the basonym for what are apparently its only synonyms: *Atamosco longifolia* Cockerell (1901), and *Atamosco longifolia* Small (1903). There are two synonyms for *Z. pulichellas* *Atamosco pulchella* (Smith) Greene (1898), and *Z. chrysanth*a Greenm. & Thomps. (1914) [Type, Texas, Chandler 7056 (MO)]<sup>1</sup>.

#### OBSERVATIONS OF EPIDERMAL DIFFERENTIATION IN REGENERATION

##### *Dugesia Dorocephala*

Margaret Anderson Gordon, *Madison College*

The regeneration of *Dugesia dorocephala* was studied in an attempt to elucidate the source and role of the cells forming the newly regenerated area. From gross, histological and histochemical observations the following summarized results and conclusions were drawn. Wound closure was first achieved by muscular contractions and the formation of a clot of mucous and rahodites. Secondarily, the wound was sealed by a growth of syncytial epidermis over the cut. The regeneration blastema was formed by the migration of parenchymal cells to the cut followed by increased mitosis. During this period of active cell proliferation, an increase in glycogen and RNA was noted in the blastema. It is possible that the glycogen served as an energy source, while RNA increased due to protein synthesis and secretion. Superficial cells of the blastema, of parenchymal origin, formed the final epidermis after the temporary syncytial covering disintegrated. The basement membrane then appeared beneath the epidermal layer presumably due to the protein secretion of the adjacent cells. The delayed appearance of the basement membrane may be important because its absence would permit regenerative interactions between the old epidermis and the blastema.

#### A NEW GENUS OF THE FAMILY *Branchiobdellidae*<sup>1</sup>

Perry C. Holt, *Virginia Polytechnic Institute*

Two new species, one from Montgomery County, Virginia, the other

<sup>1</sup>Research supported by grants from the National Science Foundation.



from Overton County, Tennessee, are removed from their former assignment to the Genus *Zironodrilus* and a new genus erected to include them. The characters upon which this genus and others are established in the family *Branchiobdellidae* are illustrated and the nature of a branchiobdellid genus is discussed.

CALCIUM DEPOSITION IN THE CRAYFISH, *CAMBARUS LOGULUS LONGULUS*  
GIRARD<sup>1</sup>

Rose Mary Johnson, *Norfolk College of William and Mary*

Studies were conducted on these crayfish for a period of two weeks following the molt. The controls consisted of eyestalkless and "normal" postmolt animals the eyestalks of which had not been removed. Both were maintained in approximately calcium-free water and were starved. The experimentals included those animals whose postmolt environment was modified by feeding or the presence of dissolved calcium in the medium.

Results showed that the organic fraction of the total dry weight increased during the two-day interval following the molt only in the "normal" controls. The percent calcium increased in both groups until the gastroliths had disappeared. The presence of dissolved calcium in the surrounding medium did not increase the uptake of calcium but those animals which were fed and those allowed to spend their postmolt time in the stream did show an increase, as compared to the controls, in percent calcium.

It was concluded that these crayfish obtained calcium from food rather than from calcium ions in the aquatic medium and that the presence of eyestalks may be necessary for the proper metabolism of organic materials following the molt.

GEOGRAPHICAL VARIATION OF THE CHORUS FROG, *Pseudacris triseriata*  
(WIED), 1839, IN THE MIDDLE ATLANTIC STATES

Duvall Albert Jones, *Madison College*

Certain morphological characters of the population known as *P. t. kalmi* are described, compared with similar characters of other forms of this species, and evaluated. Different phenotypic combinations appear to be correlated with types of environment, irrespective of geographical areas. Since the populations from which *P. t. kalmi* was described do not differ

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<sup>1</sup>These studies were supported by a National Science Foundation Award at the Mountain Lake Biological Station during the summer of 1960.

greatly from *P. t. feriarum*, and are not reproductively isolated from this adjacent form, *P. t. kalmi* is considered synonymous with *P. t. feriarum*. From observations made in the field and preliminary breeding experiments, it appears that *P. triseriata* should be considered separate from *P. nigrita*.

MARL DEPOSITION BY THE ALGAE *OOCARDIUM STRATUM* AND *CHARA*  
*VULGARIS* IN MONTGOMERY COUNTY, VIRGINIA

Harold L. Mathews, *Virginia Agricultural Experiment Station, Blacksburg*

A study was made to determine the origin of the calcium carbonate found in certain first bottom soils of the limestone valley region of Virginia. It was found that the alga *Oocardium stratum*<sup>1</sup> played an important part in the precipitation of calcium carbonate in swiftly flowing streams and that the alga *Chara vulgaris* precipitated small mounts of calcium carbonate in still and eddy water. The calcium carbonate precipitated by these algae had its origin in the highly faulted dolomitic limestone underlying the area. Ground water, high in dissolved carbon dioxide, percolating through the crushed limestone dissolved an appreciable amount of calcium and magnesium carbonate. This ground water issued at the surface in the form of large springs and lost some of the dissolved carbon dioxide resulting in a saturated solution with respect to calcium carbonate. It was below the point of saturation in the stream that the algae precipitated calcium carbonate.

The calcium depositing alga *Calothris viguieri* was observed but was thought to play a very minor part in the marl precipitation. Several species of non calcium depositing algae were observed growing in association with the marl farming algae.

THE EFFECT OF PHOTOPERIOD ON CERTAIN FERNS

Paul M. Patterson and A. Sewell Freeman, *Hollins College*

Ferns growing in the college greenhouse and taken from the woods before frost were grown in the natural photoperiod through the winter, duplicates were grown under a photoperiod of 15-16 hours, and a triplicate were potted and placed outside of the greenhouse until March.

*Pteris vittata* proved neutral to photoperiod, growing and sporulating under both. *Adiantum capillus-veneris* grew under both photoperiods, but sporulated under long day. *Polystichum acrostichoides* grew vegetatively and sporulated under long day, whereas *Woodisia obtusa*, *Dry-*

<sup>1</sup>The algae were identified by Dr. G. W. Prescott, Michigan State University.

*opteris novaeboracensis* and *Asplenium platyneuron* grew vegetatively under long photoperiod but remained sterile. Evidence from *Woodsia* and *Asplenium* growing elsewhere in the greenhouse that sporulation is induced by a day-length approximating 13 hours.

*Denstedtia punctilobula* and *Osmunda cinnamomea* required cold to break vegetative dormancy.

NUTRITIONAL REQUIREMENTS FOR ASCOSPORE GERMINATION: *Podospora anserina* NIESL

James E. Perham, *Randolph-Macon Woman's College* and  
A. Gib DeBusk, *Florida State University*

There is evidence that germination of ascospores of *Podospora anserina* is nutritionally dependent. The most effective of all compounds tested in germination studies is ammonium acetate which gives a maximum germination of 98%. Nitrogen in the form of nitrate cannot replace the ammonium ion in this function.

The results of experiments wherein various combinations of nitrogen and carbon sources were tested for their ability to stimulate the incorporation of glucose-C<sup>14</sup> and acetate-C<sup>14</sup> are presented. Accumulation of acetate-C<sup>14</sup> occurred only in the presence of ammonium ion while the incorporation of glucose required the presence of both the ammonium ion and the acetate ion. Glucose-C<sup>14</sup> accumulation also occurred in the presence of urea.

The energy requirement for the active incorporation of the acetate ion was established by inhibition of acetate-C<sup>14</sup> uptake with sodium azide and carbon monoxide, known inhibitors of oxidative phosphorylation. Attempts to inhibit the uptake of acetate-C<sup>14</sup> with chloramphenicol failed.

A MONOGRAPH OF THE GENUS *Aphanomyces*

William W. Scott, *Virginia Polytechnic Institute*

The purpose of this investigation is to present a new account of the genus *Aphanomyces*, to bring together in one paper the published studies dealing with the morphology and taxonomy of the various species, and to add to this information conclusions based upon my personal observations of living and preserved material. The majority of living specimens was obtained from approximately 550 collections of soil, water, plankton, and insect exuviae made by the writer and others in 13 states and in Alaska, Laborador, New Zealand, Cuba, and Puerto Rico.

The procedure used in the isolation and propagation of species of



*Aphanomyces* is presented. These techniques are essentially similar to those employed by other students of the water-molds. All living isolates were obtained and propagated on small pieces of sterilized snake skin or on halves of sterilized hemp seed (*Cannabis sativa*). Bacterial-free isolates were secured, and the fungi were then cultured and their morphological characteristics observed under standardized conditions.

An account of the developmental phases in the life-cycle of a representative species, *Aphanomyces laevis*, as well as a discussion of the morphological variations and abnormalities in this and related species is presented. An attempt has also been made toward the clarification of the descriptive terminology applied to the morphological characteristics of these fungi.

Insofar as possible, the relationships of species withing the genus has been indicated. The genus is readily divisible into three main categories on the basis of oogonial wall ornamentation. Such a separation is proposed with the erection of three subgenera, *Aphanomyces*, *Axyromyces*, and *Asperomyes*. A key to the subgenera of *Aphanomyces* as well as keys for the identification of species within each of these taxa are provided.

As a result of this investigation twenty-five species are recognized as valid members of the genus *Aphanomyces*, including three species (*A. patersonii*, *A. bosminae*, *A. irregulare*) described as new. One new combination is proposed and four taxa are considered synonymous. One species (*A. gordejevi* (Skvortzow) has been so incompletely described as to justify its exclusion from the genus.

## SOME NEW AND UNUSUAL FUNGI FROM VIRGINIA

### I AQUATIC HYPHOMYCETES

William W. Scott and Charles Warren, V. P. I.

In a preliminary survey of the aquatic hyphomycete flora occurring on submerged, decaying angiosperm debris from streams and ponds in the Blacksburg area of Montgomery County, Virginia, 13 species representing 11 genera were found. The species were described, and sporogenesis in each species was discussed. One species, *Heliscus Tentaculus*, had not been described previously, and was proposed as a new species. The methods and techniques used in the isolation and establishment of pure cultures were described, and the cultural characteristics of five species grown in pure culture were discussed. A brief discussion of the possible significance of the spore shapes and the formation of appressoria was presented in regard to the facility with which these spores became attached to the substratum. The apparent host specificity exhibited by *Campylospora chaetocladia* Ranz., with respect to its occurrence in other localities

was discussed. The idea was advanced that the perfect stages for some of these fungi might be found growing internally within the vascular tissues of the host plants.

## SOME NEW AND UNUSUAL FUNGI FROM VIRGINIA. II

### Keratinophilic species

William W. Scott and Roland Seymour, *V. P. I.*

Techniques for the isolation of aquatic fungi utilizing selective "baits" were discussed. Certain phycomycetous species exhibiting a preference for keratin — containing animal tissues were described. The morphology and life cycle of *Leptolegniella keratinophilum* was described for the first time from Virginia and its taxonomic status was discussed. A polycentric chytrid, isolated on keratin substrats, was described as possible representing a new genus. *Blastocladia sparrowii*, *Leptomitius lacteus*, and *Rhipidium americana* were reported for the first time from Virginia.

## A PRELIMINARY REPORT OF THE AQUATIC FUNGI ASSOCIATED WITH DISEASED FISH AND FISH EGGS

William W. Scott, *V. P. I.*

Aaron H. O'Bier, *Stetson University*

James Powell, *V. P. I.*

Sixty-four isolates of aquatic fungi were collected from fish and fish eggs from 14 states. Pure unifungal cultures were obtained from these and the following fungi were identified:

<i>Saprolegnia parasitica</i> (14 strains)	≠* <i>Aphanomyces laevis</i> (1 strain)
<i>Saprolegnia ferax</i> (1 strain)	<i>Aphanomyces</i> sp. (5 strains)
≠* <i>Saprolegnia delica</i> (7 strains)	* <i>Pythium ultimum</i> (1 strain)
<i>Saprolegnia monoica</i> (5 strains)	≠ <i>Pythium</i> sp. (5 strains)
<i>Saprolegnia</i> sp. (14 strains)	≠ <i>Allomyces anomalus</i> (1 strain)
* <i>Achlya bisexualis</i> (6 strains)	≠ <i>Leptomitius lacteus</i> (2 strains)
* <i>Achlya americana</i> (2 strains)	

Species preceded by an asterisk (\*) are reported for the first time as naturally occurring fish pathogens. Those with the symbol ≠ were isolated from fish eggs for the first time.

Inoculation studies demonstrated that *Saprolegnia parasitica*, *S. ferax*, *S. delica*, *S. monoica*, *Achlya bisexualis*, and all isolates of *Saprolegnia* sp. would grow on wounded platyfish under controlled laboratory conditions. The remaining species listed above could not be inducted to grow on fish under experimental conditions.

A PRELIMINARY ECOLOGICAL STUDY OF THE BRYOZOAN, *Lophopodella Carteri* (HYATT) IN VIRGINIA

Tenney, Wilton R. and William S. Woolcott, *University of Richmond*

*Lophopodella carteri* was collected in Virginia for the first time on October 20, 1961 at the Stevensville State Fish Hatchery, Stevensville, King and Queen County, Virginia. Colonies were abundant and were attached to a variety of substrata including concrete spillway walls, pine wood spillway gates, creosoted pilings, submerged tree branches, and floating algal mats. The pH of the water ranged from 4.6 in October to 6.4 in January. The lowest O<sub>2</sub> content reported was 10.4 ppm in April, 1962; the highest was 11.8 ppm in March, 1962. The lowest CO<sub>2</sub> readings at 1.0 ppm were also obtained in April; 3.0 ppm were found in January. A commercial fertilizer program was initiated in 1961 with no apparent effect on the bryozoan. Colonies persisted into December when the water temperature was 9 C, and the first new growth appeared in April when the water temperature was 17 C. No colonies were present between December and April; the lowest water temperature recorded during this period was 0 C in January. Representatives of virtually all major freshwater invertebrate phyla have been found in the immediate vicinity of the colonies. Snails, flatworms, and insects which are reported to feed on *L. carteri* were present in great numbers. Statoblasts of *Pectinatella sp.* were found, but active colonies of that bryozoan were not observed. In the laboratory, aquaria were prepared by mixing water and debris from the Stevensville ponds with spring water, and then were inoculated with statoblasts. A high percentage of these germinated and numerous colonies of 25 to 30 polypides each developed. They were noted to feed on the single-celled *Trachelomonas sp.* The cultures were maintained for approximately two and one-half months. More detailed ecological studies are in progress and are supported by a grant from the University of Richmond.

THE INFLUENCE OF FORMALIN AND BODILY RESTRAINT ON THE BLOOD PRESSURE AND BODY TEMPERATURE OF YOUNG CHICKENS

K. W. Washburn and H. S. Siegel, *Virginia Polytechnic Institute*

The influence of bodily restraint and 0.1 ml. of 0.1 percent injected formalin on body temperature and blood pressure of 9 week male White Plymouth Rock chickens was observed. As determined by hemodilution and adrenal cholesterol depletion bodily restraint constituted a measurable stress but the formalin injection did not. Furthermore, a significant reduction in body temperature and an increase in blood pressure was found in the restrained birds, but not in the formalin injected group.

Since the injection of 0.1 ml. of 0.1 percent injected formalin



did not produce a measurable stress effect a second experiment was conducted in which the influence of 0.1 ml. of .2, 2.0 and 20.0 percent injected formalin on body temperature and blood pressure was observed. This range of concentration of injected formalin did not produce a measurable stress effect as determined by changes in adrenal weight and cholesterol depletion, plasma glucose and cholesterol concentrations and hemodilution. There were no significant differences in body temperature or blood pressure among the treatment groups.

## SECTION OF CHEMISTRY

E. C. Cogbill, *Chairman*

R. G. Steinhardt, *Secretary*

M. A. Kise, *Section Editor*

### MINUTES

The business meeting of the Chemistry Section was held at 11:45 A.M. May 11, 1962. The meeting was called to order by Dr. Everett C. Cogbill, Chairman. A motion to dispense with the reading of the minutes of the previous meeting was carried.

The report of the Nominating Committee was presented by Dr. W. A. Powell. The committee offered the following slate of officers for the 1962-1963 year:

Chairman — Dr. R. G. Steinhardt, Jr.

Secretary — Dr. Russell J. Rowlett, Jr.

These officers were elected by unanimous vote.

Dr. R. G. Steinhardt moved that the Section empower a committee, to be appointed by the Chairman, to investigate and publicize the opportunities for summer employment of undergraduate chemistry majors in the Commonwealth of Virginia. After discussion, the motion was passed unanimously.

As there was no further business, the motion to adjourn was passed.

R. G. Steinhardt, Jr., Secretary

### THE THERMODYNAMICS OF THE MOLTEN SALT SYSTEM $\text{KNO}_3\text{-AgNO}_3\text{-K}_2\text{CrO}_4$ FROM ELECTROMOTIVE FORCE MEASUREMENTS

Robert M. Auburn and William J. Watt, *Washington and Lee University*

Measurements of the activities of  $\text{AgNO}_3$  were made in the molten salt concentration cell



at various temperatures for dilute solutions (less than 1 mole per cent) of  $\text{Ag}^+$  and  $\text{CrO}_4^{=}$ . The deviations from ideality observed are related to the concentration of  $\text{K}_2\text{CrO}_4$ , the temperature, and the concentration of  $\text{AgNO}_3$ . Comparison was made between the effect of chromate ion with those of sulfate ion and chloride ion which have been previously reported.

#### OXIDATIVE REARRANGEMENTS OF TETRAPHENYLPYRROLE

David W. Boykin and Robert E. Lutz, *Cobb Chemical Laboratory, University of Virginia*

Lead tetraacetate and chromium trioxide-acetic acid oxidize tetraphenylpyrrole (I) to 2-hydroxytetraphenylpyrrolinene (II) which then undergoes rearrangement to 3,3,4,5-tetraphenylpyrrolone-2 (III). Hydrogen peroxide-acetic acid converts tetraphenylpyrrole into dibenzoylstilbene oxide (IV) and phenyldibenzoylmethane enamine-benzoate (V). Also the hydroxypyrrolinene (II) is converted by this reagent into IV and V. The hydroxypyrrolinene (II) is interconvertible with its methyl ether VI, is hydrolyzed under special conditions to dibenzoylstilbene (VII), and is reduced by HI to I; and it is prepared from VII by ammonia. The ether VI is obtained from I by  $\text{PCl}_5$  and methanol. Dibenzoylstilbene oxide (IV) is converted by ammonia into V. These relationships and possible mechanisms were discussed.

#### SPECTROPHOTOMETRIC STUDIES ON HYDROXAMIC ACIDS AND THEIR REACTIVITY WITH METALLIC IONS: DETERMINATION OF VANADIUM (V) WITH 2-NAPHTHYLHYDROXAMIC ACID

Virginia C. Chamblin and John H. Yoe, *Pratt Trace Analysis Laboratory, University of Virginia*

This paper was a continuation of the one presented at the 1961 Academy meeting. The reactivity of some 35 hydroxamic acids (several of them new compounds) with a large number of metallic ions was briefly discussed, especially from the standpoint of the effect of various substituent groups on the reactivity of hydroxamic acids. A method for the spectrophotometric determination of traces of vanadium with 2-naphthylhydroxamic acid was presented.

## STUDIES OF ANTIOXIDANTS AND INHIBITOR MECHANISMS AT ELEVATED TEMPERATURES

James W. Cole, Jr., Oscar R. Rodig, Robert K. Schlatter and Ertle Thompson, *University of Virginia*

This was a continuation of oxidation studies at 204° C of mixtures in a fluid medium of the synthetic di-ester type. The phenomenon of apparent activation of certain amines to become more effective oxidation inhibitors by the presence of both metallic copper and its compounds is more general than originally noted with pyridine derivatives in di-(2-ethylhexyl) sebacate. Metal coordination complexes appear to be a factor in the mechanisms either as active antioxidant species, or as starting points and catalysts for the generation of oxy-species which act as the antioxidants. Related to this is the behavior of the two oxidation states in copper and shifts between the states, which might give rise to magnetic phenomena having some influence in the antioxidant mechanisms. The syntheses and behavior of twenty-seven new compounds were described.

## CHARACTERIZATION AND DETERMINATION OF ALDEHYDES BY THE ULTRAVIOLET SPECTRAL CHANGES RESULTING FROM ACETAL FORMATION

E. P. Crowell, C. J. Varsel, *Philip Morris Research Center* and W. A. Powell, *University of Richmond*

Acetal formation in conjunction with ultraviolet spectrophotometry has been employed in our laboratory as a convenient and useful analytical tool for the characterization and determination of aldehydes. The ultraviolet spectra of acetals formed from aldehydes in solutions of acidified methanol are significantly different from the spectra of the parent aldehydes in neutral methanol. This difference results because the carbonyl chromophore becomes masked as a result of the acid catalyzed reaction between the aldehyde and the methanol to form the corresponding acetal. The advantages, disadvantages, interferences, and exceptions to this technique as applied to qualitative and quantitative analysis were discussed.

 $\alpha$ -DIKETONES FROM  $\alpha$ ,  $\alpha'$ -DIBROMOKETONES

George H. Denny, Jr., and Robert D. Wysong, *Virginia Polytechnic Institute*

Acid hydrolysis of 5,5-dimethyl-2,4-dibromo-3-hexanone gives 5,5-dimethyl-2,3-hexanedione (37%), no isolable 3,4-diketone, and 44% recovery of starting material. Identical treatment of 5,5-dimethyl-2,2-dibromo-3-hexanone results in 90% recovery of starting material. This shows that (1) formation of the  $\alpha$ -diketone proceeds predominantly without rearrange-



ment, (2) oxidative replacement of bromine occurs preferentially at position two, and (3)  $\alpha$ - $\alpha'$ -isomerization is an unlikely step during  $\alpha$ -diketone formation in acid. The absence of a neopentyl rearrangement during the conversion casts doubt upon the validity of mechanisms involving the formation of a carbonium ion at position four.

#### MODELS OF MOLECULAR ORBITALS

Edward B. Eadie, Jr., and John H. Wise, *Washington and Lee University*

A project to construct effective models of atomic orbitals presented at the 1961 meeting of the Virginia Academy of Science has been extended to illustrate the formation of molecular orbitals. The orbitals were presented in the form of a correlation diagram, showing the orbitals of the isolated atoms and of the "united" atom, as well as the intermediate molecular orbitals.

#### A NEW SECOND LEVEL COURSE IN CHEMISTRY: PROGRESS REPORT

Beatrice E. Gushee, *Hollins College*

Descriptions were given of two second level chemistry courses. One departs considerably from the usual qualitative and quantitative courses by treating them as a single course in analytical chemistry. The other departs more radically from the usual course. It is entitled *Principles of Chemistry* and is devoted to a study of chemistry rather than of chemical analysis. Tentative results seem to indicate that, given the right conditions, the second course produces a better knowledge of chemistry without sacrificing ability in analysis.

#### A THEORETICAL STUDY OF REACTION EFFICIENCY

Frederick M. Hornyak, *Virginia Polytechnic Institute*

The general homogeneous, irreversible, second-order reaction  $X(\text{CH}_2)_nX + P \rightarrow X(\text{CH}_2)_nY \text{ (I)} + Q$  in which all X's are equally reactive or related in reactivity by a simple law was analyzed to determine the maximum theoretical yield of I; various concentrations and modes of addition of reactant P were examined. The implications for organic chemistry were discussed.

#### THE CATASTROPHIC OXIDATION OF ALUMINUM IN CONTACT WITH MERCURIC HALIDES

D. A. Jackson, Jr., and H. Leidheiser, Jr., *Virginia Institute for Scientific Research*

The oxidation of aluminum and aluminum alloys in air at 30° C was studied under conditions where the surfaces were exposed to mercury, liquid mercury alloys and mercury salts. The rate of oxidation in the presence of  $\text{HgI}_2$  increased greatly with increase in relative humidity. The nature of the products formed under different experimental conditions was studied by X-ray diffraction analysis, by chemical treatments and by gravimetric analyses.

#### UNSATURATED CYCLIC SULFOXIDES

Robert C. Krug and Donald E. Boswell, *Virginia Polytechnic Institute*

Recent work in this laboratory has established that 2,5- and 2,3-dihydrothiophene 1-oxides (I and II, respectively) can be prepared by the reduction of thiophene followed by the oxidation of the isomeric dihydrothiophenes with hydrogen peroxide. Certain physical and chemical properties of these new compounds, I and II, were reported.

#### MASS SPECTRA CORRELATIONS AND APPEARANCE POTENTIALS OF THE MAJOR TOBACCO ALKALOIDS

W. F. Kuhn, C. J. Varsel, *Philip Morris Research Center* and  
W. A. Powell, *University of Richmond*

The mass spectra of some major tobacco alkaloids have been determined and correlations between the spectra and structures of these alkaloids were discussed. The more abundant peaks in the spectra of the alkaloids result from the following mechanisms: (1) The ionization of the molecule; (2) loss of a hydrogen atom from the molecule; (3) bond rupture between the pyridyl nucleus and the nucleus of the cyclic amine; and (4) splitting out  $\text{CH}_3\text{N}$  neutral fragment. The molecular weights of these alkaloids are readily determined from their intense molecular ions. The appearance potentials of the major ion species from these alkaloids were measured and probable modes of ion formation were discussed. The design of a heated inlet operable at 200° C and  $1 \times 10^{-6}$  torr was presented.

#### BASE-INDUCED HYDROLYTIC REARRANGEMENT OF *trans*-gamma Bromodynone to 1,2-Dibenzoylthane

Robert E. Lutz, L. T. Slade and P. A. Zoretic, *Cobb Chemical Laboratory, University of Virginia*

Ethanollic sodium hydroxide induces hydrolytic rearrangement of *trans*-gamma-bromodynone to 1,2-dibenzoylthane which does not appear im-

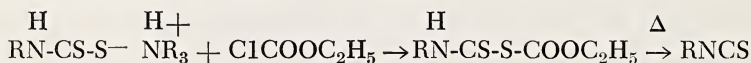
mediately in the still-alkaline solution but forms slowly from a persistent intermediate. Phenyl group migration from the 3 to 4-position of the dyponone skeleton during this rearrangement and during similar reductive rearrangements of cis and trans-gamma-dyponone oxides was excluded by repeating the reactions upon materials  $C^{14}$  labeled at the 1 and 3-carbons, followed by permanganate oxidation of the respective products to benzoic acid, in each case with retention of the full  $C^{14}$  activity. Rearrangement mechanisms were offered in terms of conventional intermediate steps involving a cyclopropane ring.

#### N-ALKOXY SUBSTITUTED DITHIOCARBAMATES

Randolph T. Major and John A. Hardy, III, *University of Virginia*

In the past, alkyl isothiocyanates,  $RNCS$ , have been made by the decom-

position of N-alkyl-dithiocarbamates,  $R-N-CS-S-$  in various ways, for example, through the reactions



Efforts have been made now to prepare the analogous N-alkoxyisothiocyanates,  $RONCS$ , by similar reactions. A report of the results to date was given. A study of reactions between thiophosgene and N-alkoxyamines has been made, also, in the expectation of obtaining N-alkoxyisothiocyanates. Results were reported. Also, a number of N-alkoxy-N-alkyldithiocarbamates have been made and some of their reactions have been studied.

#### MEASUREMENT OF PARAMAGNETIC SUSCEPTIBILITY

Kerford A. Marchant, Jr. and John H. Wise, *Department of Chemistry*  
and E. F. Turner, Jr., *Department of Physics, Washington and Lee University*

Recently, a description of experimental procedures for obtaining paramagnetic susceptibility measurements has appeared in the literature. An electromagnet constructed in the Physics Department has been adapted for such measurements, with the possibility of use as an experiment in Physical Chemistry.

#### THE INITIAL STAGES OF OXIDATION OF A COPPER SINGLE CRYSTAL

Don F. Mitchell, K. R. Lawless and A. T. Gwathmey, *Cobb Chemical Laboratory, University of Virginia*



Single crystals of copper were oxidized at low oxygen pressures and over a range of temperatures from 100°C–900°C. The initial changes in the metal surface on exposure to oxygen were studied by means of electron diffraction and electron microscopy. Results indicate at least three stages in the development of an oxide film: (1) solution of oxygen in the metal, (2) the development of isolated nuclei of cuprous oxide, (3) a lateral growth of the nuclei by a process of surface diffusion.

THE SYNTHESIS OF N-(3-CARBOXYHYDRAZONOPROPANOYL)-4-AMINO BENZOIC ACID AND ITS USE AS A CARBONYL REAGENT

James K. Shillington, Henry C. Hawthorne, Jr., Bruce T. Houghton,  
*Washington and Lee University*

The study of the synthesis of bifunctional carbonyl reagents for use in the isolation and identification of aldehydes and ketones has been continued. N-(3-Carboxyhydrazonopropanoyl)-4-aminobenzoic acid (I) is synthesized by hydrazination of N-(3-Carbomethoxypropionyl)-4-aminobenzoic acid (II). Compound II is prepared by the reaction of 3-carbomethoxypropionyl chloride and para-aminobenzoic acid. The acid (I) is condensed directly with the carbonyl compound. Ready condensation with a number of carbonyl compounds showed the reagent to be versatile and the derivatives to be stable crystalline solids with suitable melting ranges.

TASTE-STRUCTURE CORRELATION WITH  $\alpha$ -D-MANNOSE AND  $\beta$ -D-MANNOSE

Ralph G. Steinhardt, Jr., Allen D. Calvin and Elizabeth Anne Dodd,  
*Hollins College*

The so-called ambiguity of taste perception of D-mannose has been traced to actual differences in taste between the two anomers of this substance. Preliminary data indicate strongly that the  $\alpha$ -anomer is sweet (sucrose-like) and the  $\beta$ -anomer is bitter (quinine-like). The difference in taste is attributed to the slight difference in structures of the anomers.

ELECTRON MICROSCOPE INVESTIGATION OF A CATALYTIC REACTION ON COPPER SINGLE CRYSTAL THIN FILMS

T. F. Swank, K. R. Lawless and A. T. Gwathmey, *Cobb Chemical Laboratory, University of Virginia*

Single crystal copper thin films about ( $500 \overset{\circ}{\text{Å}}$  thick) were used under various conditions to catalyze the reaction of  $\text{H}_2$  and  $\text{O}_2$  to form water. After the reaction, these copper films were studied by transmission electron microscopy. A uniform distribution of individual dislocations was

observed. It was possible to identify the initial stages of facet formation along with surface growths such as "powder." There seems to be no simple correlation between the dislocations and the initiation of facets or surface growths. It appears that the individual powder particles are single crystalline but they are randomly oriented with respect to one another making the aggregate polycrystalline.

#### PREPARATION OF HIGH-PURITY SINGLE-CRYSTAL BORON

Claude P. Talley and Gerald R. Taylor, Jr., *Exploratory Research Laboratory, Texaco Experiment Incorporated, Richmond, Virginia*

Because of its relatively high band gap, elemental boron holds considerable promise for use in high temperature semiconductor devices. This work reported the first successful attempt to make large simple crystals of elemental boron in a controlled manner and represents an initial step toward providing the necessary understanding of the solid-state physics of this element. To accomplish this, an apparatus was built and used for producing cylindrical rods of relatively pure polycrystalline boron by chemical vapor plating. An electron-beam floating-zone melting apparatus was built for single crystal growth and zone refining of these rods. X-ray radiograms of boron through which the molten zone was slowly passed showed the accumulation of impurities in the molten zone. Single crystal rods of  $\beta$ -rhombohedral boron approximately 1.5 mm in diameter and over 1 cm in length were produced.

#### A NOVEL SYNTHESIS USING GRIGNARD REAGENTS

Frank A. Vingiello, Sih-Gwan Quo and John Sheridan, *Virginia Polytechnic Institute*

We have recently found [F. A. Vingiello, Sih-Gwan Quo and John Sheridan, *J. Org. Chem.*, 26, 3202 (1961)] that one may couple aryl Grignard reagents to benzyl systems to obtain high yields of the crossed condensation product. The reaction is quite broad in scope and may be used with a large variety of benzyl-type systems which may contain either electron-attracting or electron-withdrawing groups and that the aryl Grignard reagent may also be so varied and that it may be mono-, poly-, or hetero-cyclic. The great utility of this reaction in organic synthesis was discussed.

#### THE SYNTHESIS OF SOME NEW THIOPHENE CONTAINING POLYNUCLEAR COMPOUNDS

Frank A. Vingiello, Sih-Gwan Quo and Perry Polss, *Virginia Polytechnic Institute*

Because of recent interest in carcinogenesis by thiophene isosters of polycyclic hydrocarbons, for example, the recent work of B. D. Tilak, *Tetrahedron*, 9, 76 (1960), we have prepared some new polynuclear compounds containing a thiophene ring. Anthracenes and benz (a) anthracenes containing the thiophene ring in the 9-position and the 7- and 12- positions respectively, have been prepared. In one case, the appropriate aryl nitride was allowed to react with either 2- or 2- halomagnesium thiophene and in the other case, the appropriate arylmagnesium halide was allowed to react with either 2- or 3- thenoyl chloride. Both routes lead to the formation of thienyl aryl ketones. Also, some interesting aspects of the acid catalyzed aromatic cyclodehydration of the ketones to the final aromatic compounds were discussed.

A STUDY OF THE SYNTHESIS AND AROMATIC CYCLODEHYDRATION OF 2-(2-NAPHTHYLMETHYL)-2'-CHLORO-5'-METHYLBENZOPHENONE

Frank A. Vingiello and Leo Ojakaar, *Virginia Polytechnic Institute*

In a recent study of cyclodehydrogenation reactions of potential carcinogenic or carcinolytic hydrocarbons by F. A. Vingiello and W. W. Zajac, *J. Org. Chem.*, 26, 2228 (1961), it was pointed out that ring closure of 12- (3-methylphenyl)-benz (a) anthracene might take place at either of the two ortho positions of the phenyl ring yielding 2-methyldibenzo (a,1) pyrene and/or 4-methyldibenzo (a,1) pyrene. In order to determine the identity of the product, an unequivocal synthesis of 2-methyldibenzo (a,1) pyrene was undertaken. The present study concerns the preparation of 2-(2-naphthylmethyl)-2'-chloro-5'-methylbenzophenone and a study of its cyclization to 2-methyldibenzo (a,1) pyrene.

THE SYNTHESIS OF 7-PHENYLDIBENZ (A,H) ANTHRACENE

Frank A. Vingiello and Paul D. Henson, *Virginia Polytechnic Institute*

Due to the present interest in the synthesis of compounds possessing biological activity and because both 7-phenylbenz (a) anthracene and dibenz (a,h) anthracene exhibit a marked carcinogenic activity, the synthesis of 7-phenyldibenz (a,h) anthracene was undertaken. The total synthesis of this hydrocarbon, the proof of structure and other interesting sidelights of the various steps involved in the synthesis were discussed.

MOLECULAR ADDITION COMPOUNDS BETWEEN IODINE CHLORIDES AND VARIOUS ELECTRON DONORS

Robert D. Whitaker, George B. Fozzard, John R. Ambrose and C. W. Hickam, *Washington and Lee University*



Binary systems involving both iodine monochloride and iodine trichloride with relatively strong and weak electron donors have been studied by means of phase diagrams, UV and visible spectrophotometry, and where possible, by isolation of products. These studies, in connection with previous investigations of other halogen, interhalogen-donor systems, have made possible a rather complete correlation of the properties of the molecular addition compounds with the properties of the parent donor and acceptor molecules.

## SECTION OF ENGINEERING

James B. Eades, *Chairman*

J. F. Eckel, *Vice-Chairman*

J. A. Friedericy, *Secretary*

N. F. Murphy, *Section Editor*

R. M. Hubbard, *Historian*

### MINUTES

The possibility of the presentation of fewer papers at next year's meeting was discussed. The contention was that a less jam packed program of selected papers would create more interest among members, and cause a rise in the attendance at the meeting. It was decided to have next year's secretary canvas the Section members to learn their opinion in this matter.

The dual section method, it was concluded, worked well and should be continued.

It was decided not to present the George Washington Award this year. The \$25.00 cash prize and certificate will be included again in next year's award.

Officers elected for next year's meeting are: Chairman, John F. Eckel, V.P.I.; Vice chairman, Johan A. Friedericy, University of Virginia; Secretary, R. K. Will, V.P.I.; Section Editor, N. F. Murphy, V.P.I.; Historian J. B. Eades, V.P.I.

Johan A. Friedericy, Secretary

### RANGE CONTROL DURING INITIAL PHASES OF SUPERCIRCULAR REENTRIES

Donald L. Baradell, *National Aeronautics and Space Administration*

The direct reentry of a manned vehicle returning from a near-lunar or deep-space mission is compared to reentry from a near-earth orbit. For

the supercircular reentry, successful recovery is seen to require some means of vehicle range control after reentry. Aerodynamic maneuvering can provide such range control.

It is shown that considerable ranges can be achieved by even low L/D vehicles operating totally within the atmosphere, if proper maneuvering is initiated early in the reentry while the vehicle still possesses supercircular velocity.

Significant extension of lateral range capability is shown to be achievable throughout much of the allowable reentry corridor by permitting the vehicle to reenter in a banked attitude.

Emphasis is placed on reentry at escape velocity but the results also apply in character to reentry at other supercircular velocities.

#### ANALYSIS OF THE OPERATION OF A STATIC SWITCHED D. C. VOLTAGE REGULATOR EMPLOYING A POWER SEMICONDUCTOR AS THE SWITCHING ELEMENT

Ricardo Berner and Eugene S. McVey, *University of Virginia  
Charlottesville*

This paper pertains to a voltage regulator using a switched series element to obtain regulation.

Although these systems have been discussed extensively in the literature in a qualitative manner, apparently little analytical work has been done due to their nonlinear nature. The results presented here are an attempt to overcome this deficiency for one particular system.

The principle of operation of a switched series voltage regulator is explained briefly. Its potential advantages and disadvantages are compared to a linear series regulator. Among the advantages are improved reliability and efficiency, higher power output, and reduced cost and size.

It is shown that power semiconductors can be better utilized when operated as controlled switches instead of as linear elements. A model has been built which is based upon the theoretical results of the investigation. The analysis of the operation compares favorably with preliminary experimental results.

#### A NUMERICAL SOLUTION TO THE PROBLEM OF INCOMPRESSIBLE FLOW IN THE INLET LENGTH OF A STRAIGHT CHANNEL

R. A. Chubboy, *Virginia Polytechnic Institute*

Flow in the inlet length of a straight channel was investigated to determine the velocity field and relation for the pressure function. The governing equations, the Navier-Stokes and continuity equations, were simplified by using the boundary layer approximations; then, non-dimensionalized and treated in finite difference form. The non-dimensional form of the equations suggests that the velocity field and pressure function are dependent upon the two parameters, Reynolds number ( $Re = \rho u_0 D / \mu$ ) and a pressure ratio ( $\beta = \rho u_0^2 / p_0$ ). By varying these parameters simultaneously, then separately, different sources of data were obtained with which the above dependence was defined.

The velocity field was found to be in good agreement with that obtained in previous investigations. The empirical relation developed for the pressure gradient however, represents an improvement over previous forms since it is applicable between any two sections in the channel. The total pressure drop given by this relation is slightly low, but by refining the difference net, it was found that excellent correlation with the experimental end-correction formula is obtained.

#### A TIME DEPENDENT SOLUTION TO THE LAUNCH VEHICLE RESPONSE PROBLEM

Dennis F. Collins, Jr., *National Aeronautics and Space Administration*

A method for the prediction of launch vehicle responses to winds within the atmosphere is presented. The complete mathematical model of the launch vehicle allows for the effects of elasticity, a gimbaled engine with a closed-loop control system, structural feedback, and fuel sloshing. Lagrange's equations, modified for use in body coordinates, are employed to obtain the differential equations of motion. The resultant system of differential equations with time-dependent coefficients is to be solved on a digital computer. Some time histories of such things as attitude angle, engine gimbal angle, and bending moment and the effect of control system gains on loads are presented. The results were obtained from a reduced form of the general equations.

#### THEORY AND EXPERIMENT FOR A ROTATIONAL PLASMA ACCELERATOR

William Grossmann, Jr., *National Aeronautics and Space Administration*

This discussion covers some of the analytical and experimental aspects of a continuous rotational plasma accelerator. This accelerator which, in principle, converts a high rotational plasma motion into translational motion is based on the following considerations. A slightly ionized plasma is simultaneously accelerated azimuthally to a very high velocity and axially to sonic velocity whereupon it is expanded in a combination solid and magnetic nozzle. It should be noted that the present accelerator



has two modes of operation: 1) conversion of rotation to translation, and (2) Hall current acceleration, and that the pressure range is necessarily higher than in a pure Hall current accelerator.

Experiments in a prototype of the accelerator have shown that a distributed arc discharge can be obtained for coaxial electrode geometry for cathode temperatures below that of thermionic emission. To date, currents of 200 amperes with a magnetic field strength of 3,000 to 13,000 gauss have been used with stagnation pressures of 10 to 35 millimeters. Operation of the continuous discharge appears to be similar to that of the "burning phase" of a pulsed homopolar device reported by Alfven and Fahleson. Experimental evidence will be given for this effect and also a description of the measurements (including those of thrust) being made in the present facility will be given.

#### COMPENSATION OF OPEN LOOP UNSTABLE FEEDBACK SYSTEMS TO ACHIEVE UNCONDITIONAL STABILITY

Orville R. Harris, *University of Virginia*

The support of ferromagnetic bodies by servo control of a magnetic field produces a pair of poles, in the  $S$ -plane, on the real axis. These two poles are symmetrically located with respect to  $S=0$  such that one pole is in the right-half plane. Hence, the open loop transfer function is inherently unstable. A method for inserting two zeros and a pole, by compensation, near the origin on the real axis has been devised which will cause the pole in the right-half plane to move into the left half, as the gain is increased, and remain there for all values of open loop gain above a certain minimum. Thus at all gain values above this gain the overall servo remains unconditionally stable.

#### EFFECT OF NITROGEN ON THE STRAIN BEHAVIOR OF 304 STAINLESS STEEL UNDER LOW STRESSES IN THE TEMPERATURE RANGE 80 TO 170° C

W. H. Herrnstein and J. F. Eckel, *Virginia Polytechnic Institute*

The effect of nitrogen on the strain behavior of 304 austenitic stainless steel under low stresses is of interest in the temperature range 80° to 170° C from the standpoint of accounting for the susceptibility of this alloy to stress corrosion cracking. Heating tests were conducted on un-nitrided and nitrided 304 sheet specimens under low static stresses in the temperature range of interest. Specimen strain was measured as a function of temperature during heating. Abrupt decreases in the rate of straining with temperature were observed. Furthermore, the temperature at which these decreases occurred appeared to be dependent upon the heat treatment and applied stress, the temperature decreasing with

both nitriding exposure time and applied stress. Discussion is presented concerning the possibility that stress induced diffusion of interstitial nitrogen is responsible for the observed phenomena.

#### VISCOSITY MEASUREMENT USING A BOURDON TUBE

Robert M. Hubbard, *University of Virginia*

A new instrument for measuring viscosity continuously is described. It requires only standard components — a synchronous motor, gear reducer, Zenith pump, constant temperature bath, and a pressure transmitter having a helical element with an open end. The liquid is **pumped at** constant temperature through the helical pressure spring. Deflection is proportional to viscosity. For a flow of 105 cubic centimeters per minute with a Reynolds number less than unity, a helical element rated 800 psi pressure can measure viscosity up to 1200 centipoises.

#### ADAPTATION OF AGRICULTURAL SOIL MAPS FOR ENGINEERING USE

John H. Hunter, and Robert D. Krebs, *Virginia Polytechnic Institute*

A portion of a study conducted by Virginia Polytechnic Institute for the Federal Housing Administration required presentation of soil interpretations by cartographic methods. Presentation of two categories of interpretations was required: a specific use interpretation (ratings of soils for residential sewage disposal) and a generalized interpretation of soil features of interest to engineers.

After mapping units were selected, the problem was reduced to selecting a proper base and to drafting and reproducing the appropriate overlays.

Since published soil survey maps are at a convenient scale, and the master film positives for the press plates are available for many modern soil surveys, the same photo-mosaic bases were used as were used for the agricultural soil surveys. The overlays, showing the different mapping units, were developed using existing film positives showing agricultural soil boundaries. The film positives for both the base and the working sheets for the overlays are available from the Cartographic Division of the U. S. Department of Agriculture.

Various steps in the preparation of the engineering map folios were illustrated. The folios are prepared on a country basis. A finished map folio for Norfolk County, Virginia, was shown.

## RECENT TRENDS IN THE PATENT SYSTEM

Auzville Jackson, Jr., *Robert Shaw-Fulton Controls Company, Richmond*

Patent matters of great current interest are the streamlining of examining procedures, including information retrieval; international licensing which includes the USSR; ownership of inventions as between the Government and its contractors; ownership of inventions as between corporations and its employees; and the better dissemination of the technical information contained in patents to the technical community.

AN INVESTIGATION OF THE FLUCTUATING FORCES ACTING ON A STATIONARY  
CIRCULAR CYLINDER IN A SUBSONIC STREAM, AND OF  
THE ASSOCIATED SOUND FIELD

Roger T. Keefe, *Virginia Polytechnic Institute*

An experiment investigation has been made of the fluctuating forces acting on a short segment of a 1-1/8" diameter stationary circular cylinder placed in the University of Toronto, Institute of Aerophysics subsonic wind tunnel. The fluctuating lift was measured over a range of Reynolds numbers from 5000 to 100,000 and the fluctuating drag over a range of 20,000 to 100,000. A large increase in the lift coefficient occurred when two circular disks were fastened to the cylinder in close proximity to the force transducer.

The measurements of the acoustic radiation from cylinders placed in a subsonic air jet showed great sensitivity to the cylinder end conditions. Experiments were performed to arrive at an understanding of the end effects, with limited success.

A comparison of a theoretical estimate of the acoustic radiation using the results of the force measurements presented herein and correlation data obtained previously at the Institute of Aerophysics shows good agreement with the acoustic measurements on one of the configurations tested, and with those of other researchers using a whirling arm apparatus.

## RATING SOILS FOR RESIDENTIAL SEWAGE DISPOSAL

Robert D. Krebs and John H. Hunter, *Virginia Polytechnic Institute*

In many suburban areas the most practical solution to residential sewage disposal is individual systems of the absorption field type. These depend on favorable soil conditions for safe performance. Soil conditions are generally rated on the basis of the percolation test, which sometimes gives misleading results. A system of rating soils that may be more accurate and versatile, though less precise, was outlined for Federal Hous-



ing Administration field scientists. The soil rating is based on the geologic, hydrologic, and topographic position of the soil; the texture, consistency, structure, and drainage condition of the soil profile; and the past performance of the soil with respect to sewage disposal, vegetation, roads, and light structures. Information on each of these features is often available in the literature or public records and can be ascertained from field study of exposures and auger borings. With this system, the engineer may efficiently utilize a wealth of basic soil survey information pertinent to residential sewage disposal. Its chief disadvantage lies in the great weight placed on the judgment of the engineer, such that his decision may appear arbitrary to the layman.

#### SPIN DYNAMICS OF MANNED SPACE STATIONS

Peter R. Kurzahls, *National Aeronautics and Space Administration*

The dynamic behaviour of manned rotating space stations under various steady-state and transient disturbances, such as docking impacts, attitude system torques, and crew motions, is discussed. The basic equations of motion for a spinning station are developed and expressions simulating the applied excitations are introduced. Two stability systems, a gyroscopic wobble damper and a proportional jet damper, are represented mathematically, and the motion of the station under the external disturbances is determined without and with the effect of these stability systems. Computer results for several example cases are included to illustrate the characteristic response of a typical station.

#### A STUDY OF THE EFFECTS OF DYNAMIC LOADS UPON THE ENGINEERING CHARACTERISTICS OF SOILS

H. G. Larew, *University of Virginia*

This paper presents the results of recent research conducted to determine the effects of repeated and dynamic loadings upon soil.

A strength criterion for failure under the action of repeated loads is presented and methods for determining the deformation moduli for soils under the action of repeated and dynamic loads are described.

#### Cr<sub>3</sub>O STRUCTURE IN THE TERNARY SYSTEMS CR-SI-SN AND V-SI-SN

P. B. Lassiter and John F. Eckel, *Virginia Polytechnic Institute*

The Cr<sub>3</sub>O or B-W structure occurs in approximately 40 known binary systems. The factors affecting the formation of these compounds are atomic size and/or electron configuration. In order to study the effects

of both of the above factors, two series of ternary alloys were prepared using both arc melting and sintering of powder compacts. Compositions varied from  $\text{Cr}_3\text{Si}$  to 75 atomic % Cr — 25 atomic % Sn in the chromium-tin silicon system, and from  $\text{V}_3\text{Si}$  to  $\text{V}_3\text{Sn}$  in the vanadium-silicon-tin system. No measurable amount of tin was found to substitute for silicon in the first system, but a continuous series of solid solutions was found between  $\text{V}_3\text{Si}$  and  $\text{V}_3\text{Sn}$ .

#### NITROGEN DIFFUSION CONSTANTS IN AUSTENITIC STAINLESS STEEL A DETERMINED BY INTERNAL FRICTION MEASUREMENTS

C. R. Manning and J. F. Eckel, *Virginia Polytechnic Institute*

The internal friction spectra for AISI 304 austenitic stainless steel have been determined for the material in two conditions, the as-received and solution heat treated condition and also the heavily nitrided and solution heat treated condition. No pronounced nitrogen relaxation peak was found in the as-received material. However, a large peak was found in the nitrided and homogenized material. Originally the lattice was supersaturated with nitrogen, but stress-induced diffusion resulted in lowering the amount of nitrogen in solution with a corresponding reduction in peak amplitude of the internal friction spectra on successive runs. A metallographic examination showed that the nature of the nitrides changed during testing from an original needle-like form to a spheroidized structure after testing.

Nitrogen relaxation peaks were found at temperatures from 192°C to 210°C for the supersaturated material in the frequency range of 0.33 to 1.09 cycles per second. Nitrogen peaks were also found in the saturated material at 249°C and 264°C for frequencies of 0.33 and 0.66 cycles per second. From these data, diffusion constants have been calculated for nitrogen in Type 304 stainless steel.

#### EFFECT OF AERODYNAMICS OF THE PERTURBATIONS OF A NEAR EARTH ORBIT AND THE BALLISTIC REENTRY TRAJECTORY

Alton P. Mayo, *National Aeronautics and Space Administration*

The equations used to calculate the effects of the sun, moon, earth oblateness, and aerodynamic drag forces on a close earth orbit and during the ballistic reentry are generally discussed. Results are presented to show the comparative effects of these forces on a 112-mile altitude orbit and the effects of orbital altitude on the altitude loss per revolution due to aerodynamic drag. The effect of increasing vehicle drag at a constant altitude is illustrated. Drag effects on ground range during the reentry

are discussed along with the altitude, velocity, acceleration, Mach and Reynolds numbers during a typical reentry.

ON THE PREDICTION OF AERODYNAMIC LOAD DISTRIBUTION ON FINITE  
WINGS BY THE SUBSONIC KERNEL FUNCTION METHOD:  
STEADY CASE-WING LOADS

John P. Mugler, Jr., *National Aeronautics and Space Administration*

A method for calculating the aerodynamic loading on a flexible wing is discussed. The Kernel function method was used to calculate the aerodynamic load for a rigid wing and the wing elastic properties were used to determine the wing deformations under load. An iteration process was set up to calculate the resultant aerodynamic loading on the flexible wing. Calculations were made for a swept wing configuration and compared with experimental results. Agreement was good at Mach numbers to 0.8 at low angles of attack. But as the Mach number or angle of attack increased, mixed flow and separation caused the agreement to become poor.

A COMPARISON OF PUBLISHED DATA WITH THEORETICAL RESULTS FOR THE  
COMPRESSIBLE TURBULENT SKIN FRICTION

John B. Peterson, Jr., *National Aeronautics and Space Administration*

The Van Driest, Wilson, and Sommer and Short  $T'$  theories of compressible turbulent skin friction were compared with experimental data in order to determine their accuracy. Results from 14 different experiments at zero heat transfer and 7 experiments with heat transfer were used. The data covered a range of Mach numbers up to 10 and Reynolds numbers up to 100 million with heat transfer and 68 million without heat transfer. The comparison between theory and experiment was made on one curve by performing a transformation on the experimental data and indicates that the Sommer and Short  $T'$  theory will provide the most accurate estimate of the compressible turbulent skin friction coefficient.

DETERMINATION OF NEWTONIAN FORCE COEFFICIENTS FOR A TYPICAL  
REENTRY CONFIGURATION

E. Brian Pritchard, *National Aeronautics and Space Administration*

Three factors which influence the design of a vehicle capable of carrying out a space mission and returning to the earth's surface include: adequate aerodynamic characteristics and thermal protection to insure safe reentry and adequate volume to encompass all desired onboard systems.

This paper is concerned with the determination of the aerodynamic



force coefficients on a symmetrical, flat-sided body having a spherical nose and cylindrical edges and a fineness ratio of 0.816.

The effect of variation of the body half angle on the vehicle's aerodynamic characteristics is analysed. It is found that increasing the body half angle results in decreasing the maximum lift and drag coefficients up to a value of the half angle of about 26 degrees. For this type body a maximum lift-drag ratio of approximately 0.4 is obtained for the body having a half angle of 26 degrees operating at an angle of attack of 22 degrees.

#### DETERMINATION OF THE TOTAL NEUTRON FLUX NEAR A REACTOR CORNER

J. D. Spencer and T. G. Williamson, *University of Virginia*

In reactor theory it is presently impossible to get a closed solution for the neutron flux in the reflector near the corner of a reactor. A hydraulic rabbit system utilizing aluminum slugs was used to measure the flux in the reflector. The slope of the flux out from the corner ( $45^\circ$ ) agree very closely with two group spherical reactor calculations and it was approximately twice the slope of the flux perpendicular to the face.

#### RADIO STAR SCINTILLATIONS

E. C. Stevenson and Jas. P. Hollinger, *University of Virginia*

Study of records of amplitude scintillation taken at several ground stations establishes the validity of the correlation method of drift analysis of Briggs, Phillips, and Shinn as extended by Phillips and Spencer. At Charlottesville, Virginia, the axial ratio of the ground pattern elliptical contours is large, averaging twenty-to-one, and therefore calculated drift velocities have large errors in both magnitude and direction. However, the orientations of the major axes are precisely determined, and show that the irregularities in the ionosphere responsible for scintillations are greatly elongated ellipsoids aligned with the earth's local magnetic field. A drift component to the west of the long axis of the ellipsoid was always present.

Records taken at four stations on an east-west line yield components of the apparent velocity of individual peaks of intensity of the ground pattern for each of the three segments of the east-to-west path. Systematic accelerations have been found which show that the ionospheric model for scintillation production should be re-examined, and that ground pattern motion may not be due primarily to drift or transport of a layer in the ionosphere.

THE EFFECTS OF NEUTRON-GAMMA IRRADIATION UPON THE PHYSICO-CHEMICAL PROPERTIES OF SOILS

M. T. Tumay, H. G. Larew, and J. Lawrence Meem, *University of Virginia*

This paper presents the results of tests made to determine the effects of two levels ( $10^{18}$  nvt and  $10^{19}$  nvt) of neutron-gamma irradiation on the physico-chemical properties of three fine-grained soils.

Studies of the induced radioactivity and changes in hydrogen ion concentration, conductivity, mineralogical content, strength characteristics, Atterberg limits, compaction characteristics and soil structure as determined with the electron microscope, are reported.

With regard to the observed safety and versatility of the nuclear methods employed in determining the irradiation effects on soil, several promising soils engineering applications of nuclear methods are recommended.

ON THE PREDICTION OF FINITE-WING FLUTTER CHARACTERISTICS BY THE SUBSONIC KERNEL FUNCTION METHOD

Gerald D. Walberg, *National Aeronautics and Space Administration*

Flutter characteristics calculated for an aspect ratio 3.5 all-movable horizontal tail are presented and compared with experimental results. The flutter analysis was of the Rayleigh-Ritz type. The flutter mode was approximated by a superposition of the model's first three experimentally measured natural vibration modes and the unsteady aerodynamic forces were calculated from the subsonic kernel function method. A brief review of the theoretical foundations of the kernel function method is presented. The calculated flutter boundaries are found to be in good agreement with experiment. The investigation is extended beyond the calculation of eigenvalues (i.e., flutter speed and frequency) to the calculation of the associated eigenfunctions (flutter mode shapes and pressure distributions). Examination of the flutter pressure distributions shows that the distribution of aerodynamic stiffness and damping forces is practically independent of Mach number in the range  $0.75 \leq M \leq 0.90$ .

SIGNIFICANCE OF LAYER DEFLECTIFN MEASUREMENTS  
IN FLEXIBLE-TYPE PAVEMENTS

Richard D. Walker, *Virginia Polytechnic Institute*

Data obtained from a test road located on U. S. 31 near Columbus, Indiana, were used to develop a system for evaluating the structural performance of existing flexible type pavement. Crack patterns, wheel track rutting, total pavement deflections, and pavement layer deflections were

analyzed. Procedure for measuring layer deflections are described.

Relative modulus values using layer deflections were calculated to compare the relative deflection of one pavement layer with another.

The important conclusions reached were that total deflections were ineffective in establishing the cause of pavement distress and knowledge of layer deflections were necessary to evaluate the pavement.

#### DYNAMIC RESPONSE OF A PULSED LIQUID EXTRACTION COLUMN

John J. Watjen and Robert M. Hubbard, *University of Virginia*

The dynamic response has been measured for a liquid extraction column  $\frac{3}{4}$  inch diameter having two and three perforated plates spaced 2 inches and pulsed from 30 to 210 cycles per minute. The system was water-acetic acid-methyl isobutyl ketone. The input perturbation was a rectangular pulse of acetic acid. A theoretical analysis of the transfer function was made for fluid flow only and for flow plus extraction. The transfer function was approximately first order, but dead times up to 26 seconds were required to obtain agreement between the linear model and experimental results.

#### THE INFLUENCE OF PRECESSION OF EARTH RENDEZVOUS ORBITS ON LUNAR MISSION REQUIREMENTS

W. R. Wells, *National Aeronautics and Space Administration*

The concept of orbital rendezvous is currently receiving serious consideration for application in various space exploration missions. With respect to a manned lunar landing mission, earth orbit rendezvous offers the advantage of collection, assembly and check out of the mission components or the possibility of fueling an assembled vehicle while in earth orbit before injection into the lunar trajectory phase.

The purpose of this analysis is to define and describe the consequences of an off-nominal situation such as a greater than anticipated stay in the earth orbit, to investigate procedures for effecting satisfactory lunar trajectories in the event of such situations, and to estimate the corresponding velocity requirements during 1968.

The presentation will include a discussion of the nodal regression of the earth rendezvous orbit plane, specific procedures and techniques which result in satisfactory lunar trajectories for off-nominal situations, a comparison and optimization of these procedures, and an estimation of the corresponding velocity requirements.



## PRELIMINARY INVESTIGATION INTO THE THERMODYNAMICS OF THE NITRIDING REACTION FOR AUSTENITIC STAINLESS STEEL

E. L. Williams, Jr., *Virginia Polytechnic Institute*

An experimental investigation was conducted to determine the change in free energy of the nitriding reaction for stainless steel AISI 304.

Various amounts of ammonia and hydrogen were passed over steel chips at different temperatures for 6 hours. The chips were analyzed for nitrogen and then an equilibrium constant ( $K$ ) was determined for the nitriding reaction. This was used to determine the change in free energy for the reaction.

It is felt that the nitrides formed were either  $\text{Fe}_3\text{N}$  or  $\text{Fe}_4\text{N}$ . The change in free energy for the reactions seem to indicate this. Further work needs to be done to prove this conclusively.

## SECTION OF GEOLOGY

E. W. Spencer, *Chairman*B. W. Nelson, *Vice Chairman*F. W. Trainer, *Secretary*W. T. Parrott, *Section Editor*

## MINUTES

The meeting was called to order by Chairman E. W. Spencer at 12:10 p.m., May 11, 1962. The minutes of the 1961 business meeting of the section were read and approved. J. L. Calver, reporting on a meeting of the Academy Council, noted that the Council had requested that section historians provide more complete and accurate records of the history of the sections. W. T. Parrott, Section Editor, asked that information relating to geological activities be forwarded to him to facilitate reporting of events and activities.

The nominating committee, consisting of J. L. Calver, J. T. Hack (chairman), and E. W. Ramsey, presented the following slate of candidates for Section offices: Chairman, B. W. Nelson; Vice Chairman, K. F. Bick; Secretary, R. L. Ellison; and Section editor, W. T. Parrott. It was moved and seconded that the nominations be closed, and the candidates were declared elected.

The meeting was adjourned at 12:25 p.m.

F. W. Trainer, *Secretary*

## A GEOPHYSICAL INVESTIGATION OF SULFIDE DEPOSITS NEAR NEW CANTON, VIRGINIA

Robert C. Barnes, *University of Virginia*

Sulfide mineralization occurs in a belt that lies just east of New Canton, Virginia. The mineral zone consists of sulfide-rich replacement lenses and discontinuous veins along a contact between porphyroblastic slates of the Arvonian formation and underlying schists of both volcanic and sedimentary origin. Nearly all mineralization was localized in the schist and from a comparison of geological and geophysical data, it is evident that the control was largely stratigraphic. The primary sulfides are pyrite, pyrrhotite, chalcopyrite, and sphalerite.

Magnetic and electric techniques were employed in the geophysical evaluation. Electric techniques consisted of self-potential measurements and vertical loop and horizontal loop electromagnetic surveys.

Due to the high magnetite content of the schists, magnetic traverses clearly defined the contact between slates and schists. A near-surface conductor of moderate size with a continuous length of more than 2400 feet was delineated by the electric techniques. Correlation between the three methods was excellent.

The study at New Canton has shown that geophysics is an effective tool in the evaluation of Piedmont sulfide deposits.

## GEOLOGY OF THE WILLIAMSVILLE QUADRANGLE, VIRGINIA<sup>1</sup>

Kenneth F. Bick, *College of William and Mary, Williamsburg*

The rocks of the Williamsville quadrangle (bounded by parallels 38°00' and 38°15' and meridians 79°30' and 79°45') are sedimentary and range in age from Early Ordovician to Late Devonian. The section may be conveniently divided into 4 major units, 2 of clastic rocks and 2 of carbonate rocks. Approximately 1000 feet of Lower and Middle Ordovician carbonates are overlain by about 3000 feet of Middle Ordovician to Middle Silurian clastics; these are succeeded by 400 feet of Upper Silurian and Lower Devonian carbonates, which in turn are followed by approximately 5000 feet of Middle and Upper Devonian clastics. The carbonate rocks seem generally to indicate periods of quiet offshore, shallow-water deposition while the clastic rocks are eroded debris derived from mountainous areas east of the quadrangle.

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<sup>1</sup>Published by permission of the Virginia Division of Mineral Resources, James L. Calver, Commissioner and State Geologist.

The rocks were deformed during the Appalachian orogeny of Permian (?) age. The major structures are anticlinoria on the northwest and southeast separated by a synclorium. Many lesser folds, several faults of minor displacement, and locally complex structure, are superimposed on the major structural pattern. Recent evidence, based on a deep well drilled 25 miles north of the quadrangle, suggests that there is a major subsurface thrust fault in the general region. It is entirely possible that the folded terrain visible at the surface in the Williamsville quadrangle does not continue to great depth. Evidence is presented that one, or more, thrust faults may underlie the quadrangle; such faults, if present, probably follow the horizon of the Cambrian Rome formation, and possibly the Middle Ordovician Martinsburg formation.

#### GEOLOGY AND THE CIVIL WAR IN VIRGINIA

Robert L. Ellison, *University of Virginia*

Terrain, both regional and local, played an important role in the campaigns of the Civil War in Virginia.

Regionally, the Blue Ridge divides Virginia into a natural battlefield including Washington, Richmond, and Tidewater Virginia on the east, and Shenandoah Valley, an avenue for north-south movement, on the west.

Following practice in modern military geology, the area around Fredericksburg has been divided into three terrains on the basis of topography, bedrock geology, soil, vegetation, drainage, and trafficability. In contrast to the other two terrains, the Piedmont is higher and more densely forested; it has more slopes; its rivers are shallower and narrower; and it is underlain by steeply dipping metamorphic rocks. The Coastal Plain Upland consists largely of tabular divides, has few streams, is underlain by unconsolidated sediments, and, in places, is very poorly drained. The Coastal Plain Lowland consists of river terraces of unconsolidated material, and is extensively cultivated.

In the Battle of Fredericksburg, Lee used topography to his advantage; and in the Battle of Chancellorsville, Lee and Jackson used the Wilderness vegetation to their advantage. The failure of Burnside's "mud march" may be attributed, at least in part, to the type of soil that is extremely tenacious when wet.

#### RELATIONSHIP BETWEEN CLAY MINERALOGY AND PARENT ROCK OF PIEDMONT SOILS

William M. Flock, *Virginia Polytechnic Institute*

Clay mineralogy of a number of residual Piedmont soils and the petro-



graphy of their parent rock were investigated in Nottoway and Prince Edward Counties. The soils consist largely of kaolin-vermiculitic or kaolin-montmorillonitic clays and mixed-layered clay minerals. The soils are characterized by the scarcity of illite. Dark red vermiculite-kaolin bearing Lloyd soils in the Baker Mountain area of Prince Edward County developed from iron rich amphibolites. Yellow-brown montmorillonitic Iredell-Mecklenburg-Bremo soils developed from calcium rich greenstones and Triassic diabase. A yellow-brown weakly montmorillonitic Helena soil developed from hornblende-biotite schist which had well developed horizontal schistosity. The red micaceous vermiculitic-kaolin Madison soils developed from feldspar rich biotite gneiss, in which the biotite weathered to vermiculite. Highly kaolinitic Cecil soils developed from muscovite-quartz rich schists, indicating that muscovite weathers chiefly to kaolinite. The formation of montmorillonite from calcium-rich silicate rocks was found to be independent of drainage and rock structure. However, the rock structure, texture, and drainage influences the formation of montmorillonite when the calcium content of a mafic rock is low. The clay minerals were found to form directly from the crystal lattice of the primary minerals. These were then weathered with montmorillonite altering to vermiculite in surface layers. Hence, all soil profiles contain vermiculite and kaolinite in the A horizon, but the character of the mixed-layered material and the relative intensities of the kaolin-vermiculite peaks clearly reflect the petrography of the parent rock.

A PRELIMINARY REPORT ON THE MINERALOGY OF THE ALBERENE SOAP-  
STONE DEPOSIT, ALBEMARLE COUNTY, VIRGINIA

Harry N. Giles, 105 *Observatory Avenue, Charlottesville,*  
*University of Virginia*

Alberene is located in southern Albemarle County, about 12 miles southwest of Charlottesville. This soapstone deposit is approximately 2,000 feet in length and averages 200 feet in width. This lenticular body dips approximately 70 degrees to the southeast and trends about N 45° E. The Lynchburg gneiss forms both the hanging and footwalls for nearly the entire length of this body. The center of the body is predominantly a talc-chlorite schist, which grades outwardly into a talc-chlorite-actinolite schist; the latter grades into a chlorite-actinolite schist, which is the predominant rock type along the outer edge of the body. Minor amounts of magnetite are present throughout the body, and erythrite and pyrite are found sporadically. This deposit is transected by numerous veins that chiefly contain ferruginous dolomite. Minor constituents of these veins in order of decreasing abundance are chlorite, talc, tremolite, pyrite, ilmenite, magnesite, serpentine, apatite, and chalcopyrite. Talc, tremolite, chlorite, and calcite are present along numerous slickensides throughout the body.

## RECONNAISSANCE MAGNETIC SURVEY OF THE NEW RIVER DISTRICT, VIRGINIA

Samuel T. Harding, *Virginia Polytechnic Institute*

The area surveyed magnetically includes the following 15 minute quadrangles: Narrows, Pearisburg, Waiteville, Pulaski, Radford, and Blacksburg. The area extends from the Blue Ridge in the southeast, across the folded Appalachians, with the northwest corner in the Appalachian Plateau.

The vertical intensity map shows magnetic trends which in part coincide with surface structural trends. A rather good correlation can be made between major magnetic trends and major surface structures, but minor structures are not shown by the magnetic data.

A well-defined magnetic trend, the highest in the area, coincides roughly with the Butt Mountain-Angels Rest synclinorium, which is structurally higher than the two adjacent downwarps: The Appalachian Plateau to the northwest and the Blacksburg syncline to the southeast. The correlation between the high position of this structure and the high magnetic intensities suggests at least some basement involvement in the surface structure.

A broad magnetic low area south of this high trend can be correlated with the Blacksburg syncline. This indicates that the basement is deeper in this region, as geologic evidence suggests.

Qualitative evidence indicates that the Clinton ferruginous sandstone formation does not have an appreciable effect on the magnetic intensities

Major faults in the region seem to be associated with long narrow magnetic troughs and highs. At best correlations are rough and their significance is not understood.

From this evidence it appears that the basement may be involved in a few of the major surface structures of this region.

## STRUCTURAL ANALYSIS OF THE CHERRY CREEK BASIN AREA, MADISON MOUNTAINS, MONTANA

Samuel J. Kozak, *Washington and Lee University*

Structures in the Paleozoic and Pre-Cambrian Units are analyzed by means of stereographic projection, statistical analysis, and tectonic profiles,

Paleozoic sedimentary rocks occur in a N 40°-45° W trending syncline, the northeast margin of which is cut by a high angle fault of unknown dip direction, trending N 50°-55° W. A second set of faults between N 60° E and N 80° E cut the Paleozoics but cannot be traced into the adjacent Pre-Cambrian gneisses.

Folding in the Pre-cambrian units trends about N 65° E and appears to be unrelated to the folding in the Paleozoics.

Fracture data from the Pre-cambrian rocks are grouped about five maxima, none of which correspond to the theoretical fracture directions expected from the fabric of folds in the Pre-cambrian. Fracture data from the Paleozoics are grouped about three maxima, two of which correspond to a shear direction and the ac direction related to the fold in the Paleozoics.

Northeast trending fractures are present in both the Pre-Cambrian and Paleozoic units and their age relationship is therefore shadowed. Northwest trending fractures are present only in the Pre-Cambrian rocks and suggest an origin during the Pre-Cambrian. The northwest directions are subparallel to faults outlining portions of the Madison Range and suggest a possible Pre-Cambrian control of Laramide uplift.

#### THE BLUE RIDGE FAULT NEAR FRONT ROYAL, VIRGINIA

Fitzhugh T. Lee, *Virginia Polytechnic Institute*

Pre-Cambrian Catoctin through Ordovician Beekmantown rocks strike northeast and, in general, have overturned dips to the southeast in the Front Royal area. They comprise the overturned northwest limb of a northeast-trending anticline.

There are two major low-angle thrusts dipping to the southeast in the Front Royal area. The southernmost fault has been designated the Front Royal fault. The other fault which crosses the area in a northeasterly direction has been named the Happy Creek fault. The Front Royal fault involved thrusting Catoctin over Elbrook one mile east of Front Royal. Movement along the Happy Creek fault brought Antietam over Waynesboro two miles northeast of Front Royal. The Happy Creek fault trace is abutted by the Front Royal fault trace 1½ miles southeast of Front Royal which indicates that the earlier Happy Creek fault was cut off by the Front Royal fault. A klippe representing part of the hanging wall of the Happy Creek fault constitutes a prominent knoll of brecciated Antietam surrounded by Elbrook and Waynesboro formation rocks ½ mile east of the junction of U.S. Route 522 and Virginia Highway 55.

Displacement on both faults decreases rapidly toward the northeast and indicated movement ceased somewhere south of the Warren-Clarke county line.



## SOME RELATION BETWEEN GEOLOGY AND QUALITY OF GROUND WATER

Robert B. Leonard, *Virginia Polytechnic Institute*

Chemical analyses of ground and surface waters are used to relate geology to hydrology as part of an investigation entitled "Ground-Water Geology along the West Foot of the Blue Ridge between Arnold Valley and Elkton, Virginia."

Precambrian crystalline rocks and Lower Cambrian clastic rocks constitute the bedrock of the Blue Ridge and its foothills. Cambrian carbonate rock and shale, commonly concealed by Cenozoic gravel and clay, underlie the eastern edge of the Shenandoah Valley. Carbonate rocks in this sequence are the major aquifers.

Water analyses are presented as bar graphs and as points on a trilinear diagram. The concentration of total dissolved solids and ratios between the concentrations of various constituents are characteristic of the geologic formation from which the water is obtained.

The concentration of total dissolved solids and the pH of water from bedrock aquifers commonly increases with increasing distance from the mountains. Sodium, potassium, chloride, and sulphate are most abundant in waters of low mineralization from the clastic and crystalline rocks. Calcium, magnesium, and bicarbonate derived from solution of limestone and dolomite are the most abundant ions in waters from the carbonate reservoirs. Water from the unconsolidated mantle is variable in quality.

Waters from the same formation are commonly more highly mineralized west of the major subsequent streams than they are to the east. The quality of water produced from most wells adjacent to these streams seems to be independent of variations in quality of the streamflow. Recharge to bedrock aquifers east of the rivers appears to be dominantly from the east.

## MAGNETIC ANOMALIES ON THE VIRGINIA COASTAL PLAIN

D. C. Le Van and R. F. Pharr, *Virginia Division of Mineral Resources, Charlottesville*

In May, 1960, the Virginia Division of Mineral Resources began a program of magnetic investigations on the Coastal Plain of Virginia. In the first phase of the study, in 1960, determinations of the vertical magnetic intensity of the earth's field were made on the ground at 610 stations spaced along 372 miles in eight traverses. All ground data were reduced to absolute values through coordination with the Fredericksburg Magnetic Observatory. In 1961 the investigation was broadened by airborne magnetic data obtained during a flight by the U. S. Navy Hydrographic

Office. The flight traversed approximately 1000 miles over the Coastal Plain of Virginia, and was planned to supplement the ground data and provide information on portions of the Coastal Plain not previously covered.

Data indicate that a major trend of positive magnetic anomalies extends from the vicinity of Emporia, Greensville County, to Currioman Bay, Westmoreland County, and northward into Maryland. This trend represents a northeastward and a southward continuation of the area of magnetic "highs" reported east of Richmond and Petersburg by Wollard in 1940. Several other magnetic anomalies have been outlined and are being studied.

#### THE FORMATION OF CALCAREOUS TUFA DEPOSITS IN MONTGOMERY COUNTY, VIRGINIA

Harold L. Mathews, *Virginia Agricultural Experiment Station, Blacksburg*

A study was made to determine the origin of the calcareous material found in certain first bottom soils of the Limestone Valley region of Virginia. It was found that the  $\text{CaCO}_3$  in these soils came from the highly fractured and faulted dolomitic limestone underlying the area. Ground water, high in dissolved  $\text{CO}_2$  percolated through the crushed limestone dissolving an appreciable amount of Ca and Mg carbonate. This ground water issued at the surface in the form of large springs and lost some of the dissolved  $\text{CO}_2$  resulting in a saturated solution with respect to calcium carbonate. The calcium depositing algae *Oocardium stratum* was found below the point on the stream where the water had become saturated and was thought to be of major importance in the deposition of  $\text{CaCO}_3$  in these streams. Other factors affecting the precipitation of  $\text{CaCO}_3$  were: increasing temperature, loss of  $\text{CO}_2$  to the atmosphere and the presence of the calcium depositing algae *Chara vulgaris* and *Calothris viguieri*. One spring was gauged during the investigation and found to have an average flow of 104 gallons per minute. Approximately 10 milligrams per liter of calcium were precipitated from the stream in the first 650 feet of flow. This could result in the deposition of as much as 2.85 tons of  $\text{CaCO}_3$  per year in the stream channel.

#### PETROGRAPHY OF THE ARVONIA SLATE, BUCKINGHAM COUNTY, VIRGINIA

Robert C. McDowell, *Virginia Polytechnic Institute*

The slate in the commercial quarries near Arvon, Virginia consists largely of quartz, chlorite, sericite, and significant amounts of albite, calcite, biotite, and magnetite. Accessory minerals include graphite, pyrite, zircon, tourmaline, rutile, and apatite. Slightly coarser grained beds are more quartz-rich.

Calculation of the norm from available chemical analyses, using modal minerals, requires the use of an aluminum-rich chlorite (amesite) in which an aluminum atom is substituted for a divalent atom in the brucite-type layer and another aluminum atom is substituted for a silicon atom in the tetrahedral position. High aluminum content is supported by X-ray diffraction studies which show the chlorite to have an (004) spacing of 3.53 Å.

The slaty cleavage was produced by rotation, recrystallization, and flattening of the constituent minerals. Locally a prominent slip cleavage is present. Two lineations are distinct, one the result of cleavage-bedding intersection and the other due to elongate mineral grains.

Two thin beds of meta-arkose occur within the slate belt slightly to the east of the presently active quarries. These contain, in order of abundance, albite, biotite, calcite, and quartz. Further east the slate is bounded by a metaconglomerate in which vein quartz and chert cobbles, jasper pebbles, and blue quartz grains are embedded in a matrix of sericite and fine-grained quartz.

Nearly a mile to the east of the active quarries a belt of porphyroblastic phyllite, presumably equivalent to the Arvonian slate, shows the effects of increasing metamorphic grade. Almandite and biotite porphyroblasts are surrounded by a matrix of quartz, biotite, and muscovite.

#### AN EVALUATION OF BIOGEOCHEMICAL PROSPECTING FOR ZINC IN THE SHENANDOAH VALLEY, VIRGINIA

E. H. McGavock, *University of Virginia*

Sphalerite occurs in commercial and lesser quantities in Beekmantown dolomite (Ordovician) of the Shenandoah Valley, Virginia. This study evaluates biogeochemistry as a prospecting tool in that area. The research was supported by the Virginia Academy of Science and Sigma Xi.

Biogeochemical prospecting utilizes the response of plants to metals in supporting soils. Ideally, the amount of a metal present in a plant will reflect the amount of that metal in soil and rock below.

Six varieties of trees, alanthus, apple, cedar, locust, oak, walnut and four different weeds broomsedge, horse-mint, Queen Anne's lace, and ragweed were used in this study.

The procedure followed consists of four steps; sampling, ashing, analysis, and data evaluation. Only known mineralized areas were investigated; no attempt was made at prospecting.

Samples consisted of second year twigs of trees or entire plants (minus



roots) in weeds. All samples were ashed in an electric furnace at 450° C. Ash was dissolved in hydrochloric acid — acetate buffer — sodium thio-sulfate solution. Analyses were made colorimetrically using dithizone in carbontetrachloride; color end-points were checked with a photoelectric colorimeter. Results were calculated as zinc ppm in ash.

This technique detected the mineralized zone at seven of eight prospects investigated. Correlation with soil samples was good.

PRELIMINARY REPORT ON PLEISTOCENE GEOLOGY,  
SOUTHERN COASTAL VIRGINIA<sup>1</sup>

J. E. Sanders, R. F. Flint, N. K. Coch, and R. Q. Oaks, Jr., *Department of Geology, Yale University, New Haven, Conn.*

Presented by R F. Flint

Detailed study of surficial sediments, geomorphology, and Pleistocene stratigraphy is in progress within a narrow strip lying parallel with and south of the James River and south of Norfolk, southern coastal Virginia. The strip being mapped extends from the present shoreline westward through the Dismal Swamp, thence northward across the Suffolk and Surry scarps, long considered to be ancient wave-cut cliffs.

West of the Suffolk scarp the Miocene Yorktown Formation is overlain by two units of uncertain age, the Sedley and Kilby Formations of W. E. Moore. In the vicinity of the Suffolk scarp the Yorktown is overlain by the Nansemond Formation of Moore; the Nansemond is truncated by the scarp. The Sedley and Kilby Formations seem substantially older than the Nansemond Formation; all are nonmarine, and their much-weathered condition suggests pre-Wisconsin age. A cypress-swamp horizon underlying the Norfolk area at -30-40 ft. identified by W. Harrison dates (Y-1047) > 50,000 years.

Post-Nansemond units include sandy alluvial fills along the James River and elsewhere, the marine Pamlico Formation (suggested by shells in spoil heaps along the Intracoastal Waterway but not yet seen in place), and lake clays and freshwater peat of the Dismal Swamp. The entire sequence is to be investigated in the 1962 field season by means of core borings.

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<sup>1</sup>Supported by 3-year contract Nonr 609(40) between Geography Branch, Office of Naval Research, and Department of Geology, Yale University, 1960-1963.

PRELIMINARY REPORT ON LATE-PLEISTOCENE AND RECENT LITTORAL AND  
NEARSHORE MARINE SEDIMENTS, SOUTH OF CAPE HENRY, VIRGINIA<sup>1</sup>

J. E. Sanders, R. F. Flint, and R. Q. Oakes, Jr., *Department of Geology,  
Yale University, New Haven, Conn.*

Presented by R. F. Flint

Detailed surface and subsurface geologic study is in progress of the continental shelf, modern shore, and adjacent inland coastal area south of Virginia Beach.

The modern shore consists of a long barrier spit which extends from south of Virginia Beach to Oregon Inlet. Southward growth of this beach and duneridge complex has isolated the lagoons of Back Bay and Currituck Sound from the sea. Marshes exist on the lagoon shores.

Former strandline features inland are indicated by a sand-ridge and mud-flat complex, which extends from Pungo Ridge eastward to the modern shore. Altitudes of ridge crests are 15 to 20 feet. In Virginia the ridges trend N-S—they are truncated by the modern shore, which trends N. 20° W. The sand ridges are thought to be ancient barriers, which originated during seaward progradation of the shore at nearly constant sealevel, owing to abundant sediment supply in the littoral-drift system. Rapid seaward growth occurred when mud was abundant; sand ridges formed when mud supply diminished.

Former lower sealevels are indicated by numerous drowned linear ridges of coarse sand on the continental shelf whose topography suggests dunes and pine-, cedar-, and cypress stumps rooted in a thin peat layer (C<sup>14</sup> age of 725±70 years (Y-924)), which are exposed after storms at low tide on the Atlantic beach.

PRELIMINARY REPORT ON PHOTOGEOLOGIC FRACTURE TRACES, SOUTH-  
CENTRAL SHENANDOAH VALLEY, VIRGINIA

F. W. Trainer and R. L. Ellison, *University of Virginia*

Fracture traces in Martinsburg shale, which commonly parallel the two principal joint sets in this region, are considered to have formed along joints. In Beekmantown dolomite, some fracture traces parallel these joint sets but many more trend along an intermediate, subordinate set. Thirty fracture traces per square mile were found in shale, and 46 per square mile in dolomite. These differences in strike and abundance are

<sup>1</sup>Supported by 3-year contract Nonr 609(40) between Geography Branch, Office of Naval Research, and Department of Geology, Yale University, 1960-1963.

attributed to selective development of traces along one joint set in dolomite because of directional differences in effectiveness of solution of the rock. Similarities in average lengths of traces (300 to 500 feet) and in angular distribution of lengths suggest that joints are similar length and angular distribution in both rocks. Records of water wells show that open fractures are more regularly distributed in the shale but that the dolomite is the more permeable rock (probably because some openings are larger or better interconnected than those in the shale). The study of fracture traces should prove useful in the study of joints and hence of ground water in fractured rocks. In hydrology it probably is particularly useful in carbonate-rock terranes because it provides evidence of directions of preferential solution of the rock.

#### THE NARROWS FAULT NEAR NARROWS, VIRGINIA

Edwin K. Via, *Virginia Polytechnic Institute*

The Narrows fault lies half a mile northwest of the town of Narrows. The fault, which extends about 35 miles to the southwest to near Tazewell, Virginia, dies out 13 miles northeast of Narrows in the nose of an anticline. There the fault is a single high angle reverse fault. Near Narrows, the fault is an overthrust with a dip of 30 to 45 degrees to the southeast. Two miles farther southwest, the dip flattens even more where two fensters occur in the overthrust block. Within these fensters are Devonian Rocky Gap Sandstone and Huntersville Chert. Locally near Chapel, 8 miles southwest of Narrows the dip of the fault is reversed where the thrust sheet has overridden the east plunging axis of the Ragged Mountain anticline.

The Narrows fault, as described, is the southeasternmost fault of a zone of displacement which lies between the Pearisburg syncline on the southeast and the St. Clair fault on the northwest. Northwest of the Narrows fault lies the overturned and faulted southeastern limb of the East River Mountain-Peters Mountain syncline, which constitutes the imbricated Piney Ridge thrust slice. The slice abuts the normal dipping northwest limb of the syncline on East River Mountain.

Judging from the history of sedimentation in the Hurricane Ridge syncline northwest of the St. Clair fault and that of the Greendale syncline southeast of the area, it would appear that Narrows faulting did not occur before Late Mississippian time. Although there may be a bit of Middle Devonian Millboro Shale preserved in one of the fensters along the Narrows fault, it would seem that overthrusting sheared off most of the Millboro Shale as well as any younger Paleozoic units which may have been present.



## RECONNAISSANCE MAGNETIC SURVEYS, CENTRAL COASTAL PLAIN OF VIRGINIA

R. S. Young, *University of Virginia*; R. W. Johnson, Jr., *Tennessee Valley Authority* and R. L. Willison, *University of Virginia*

Four magnetic traverses, oriented northwest-southeast and aggregating 307 line miles, were completed across the Coastal Plain of Virginia, between the James and Rappahannock Rivers. One hundred seventy-six stations were occupied with maximum station separation of two miles along primary roads. Total field time required was fourteen hours. Instrumentation was a Jander vertical force, flux gate magnetometer, Model 1957.

Significant changes in magnetic background slope and two areas of anomalous magnetism were detected. Background changes are apparently related to "basement" topography; the two anomalies are the result of changes in rock susceptibility. Group "A" is a complex of well-defined anomalies, maximum recorded intensity of 2,460 gammas, trending N.23° E from Bottoms Bridge to Tappahannock. Total strike length is unknown. Depth estimates range from 0.35 mile to 0.9 mile, from the southwest traverse to the most northeasterly. Anomaly "B" is broad, low-value, and poorly-defined; it is best developed in the Gloucester Court House area. Depth estimates average 0.4 mile.

The relationship of Anomaly Group "A" to the background profile suggests block faulting and tabular, basic intrusives, possibly similar to Triassic fault basins in the Piedmont. Anomaly Group "B" probably results from susceptibility changes in the crystalline basement.

## SECTION OF MEDICAL SCIENCES

E. S. Higgins, *Chairman*

L. A. Mounter, *Secretary*

W. P. Anslow, Jr., *Section Editor*

## MINUTES

No minutes were submitted from this section.

P. B. Siegel, *Editor*

## FLUID THERAPY AND NORMOTHERMIA IN HEMORRHAGIC SHOCK IN THE CAT

Eugene D. Brand, *University of Virginia School of Medicine*

Half and half isotonic glucose and saline given throughout the period of development of shock to a total of 20% of body weight prolonged sur-

vival from 18 to 36 hours (5 cats). Addition of cat plasma (total 4% body weight) to the above therapy further prolonged survival to 44 hours (6 cats). Morality was 100% in control (21) and treated (16) cats. Control shocked cats are poikilothermic. Normothermia during the stimulus of hemorrhagic hypotension increased 3 fold the injury from a given stimulus (8 cats). During the response normothermia shortened survival to 5 hours. Four of these 17 cats survived.

#### THE USE OF HIGH INTENSITY LIGHT ON EXPERIMENTAL INTRAOCULAR TUMORS

Guy Chan, M.D. and W. J. Geeraets, M.D., *Medical College of Virginia*

Coagulation of intraocular malignancies with high intensity light has been discussed in the literature. Two steps were recommended for the treatment:

1. Coagulation barrages encircling the tumor to block nutrition and prevent metastasis.

2. Direct coagulation of the tumor.

Experimentally effectful barrages were obtained if a double line of coagulation spots was used, if no gaps were left between the spots and when the barrage was located away from areas where ciliary arteries penetrated the sclera. Complete blockage of choroidal circulation within the encircled barrage was possible only for 7 days with highest allowable energies.

Pigmented tumor cells were completely destroyed if the tumor was not thicker than one millimeter. Non-pigmented tumors were damaged to a great extent but viable tumor cells remained in many instances.

#### EFFECTS OF REDOX SYSTEMS ON ACTIVE ION TRANSPORT IN ISOLATED FROG SKIN

Ernst G. Huf, Leah L. Eubank, Addison D. Campbell and Barbara B. Taylor, *Medical College of Virginia*

Under anaerobic conditions frog skin reduced readily toluylene blue, brilliant cresyl blue, dichlorophenol-indophenol, thiamine and, less readily, methylene blue. Redox dyes with a stronger negative  $E'_0$  were more slowly reduced. This and other information lends support to the assumption that the redox potential in epithelial cells of frog skin under aerobiosis is probably slightly negative. Many redox systems when applied to isolated skin under aerobiosis produced changes in short circuit current (active  $\text{Na}^+$  transport) and skin potential. The epithelium was more sensitive

than the corium. Hydroquinone and especially quinone ( $E'_0 = +279$  mV) were mainly depressive. Janus green and Janus red (reduces Janus green  $E'_0 = -256$  mV) stimulated the electrical activity of skin for as long as one hour, especially when applied to the epithelium. Redox chemicals with an  $E'_0$  value near zero gave ambiguous results, i.e., stimulatory as well as inhibitory effects when tested on different pieces of skin. The observations are tentatively interpreted by assuming interaction of the extrinsic redox system with a co-factor (FAD?) in cellular oxidation necessary for active  $\text{Na}^+$  transport. The "reductive dephosphorylation" reaction described by Chance may be the key reaction involved:  $\text{ATP} + \text{reduced flavoprotein} + \text{DPN}^+ \rightarrow \text{ADP} + \text{P}_i + \text{DPNH} + \text{oxidized flavoprotein} + \text{H}^+$ . This reaction could supply the energy and also  $\text{H}^+$  for forced ion exchange in the mechanism of active  $\text{Na}^+$  transport.

#### ACTIVE SODIUM TRANSPORT ACROSS THE SKIN IN INTACT FROGS

Addison D. Campbell, Carey Stronach, and Ernst G. Huf, *Medical College of Virginia*

Active ion transport is an ubiquitous process. Isolated frog skin is a very suitable "model membrane" for studies of active  $\text{Na}^+$  transport, which takes place in the inward direction. Results from several laboratories, including our own, have shown that the "short circuit method" and the "radio- $\text{Na}^+$  flux method," when applied to the same piece of isolated tissue, give the same value for rate of active  $\text{Na}^+$  transport. Similar studies on intact skin of anesthetized frogs, have led to results which, as a rule, differ from observations on isolated skin. Two plastic "probes" were inserted through a small cut in the abdominal wall and positioned face to face with the skin between the probes. The probes were made of rigid plastic tubing, closed at one end. Two leads in the tubes were provided for measurement of skin potential and application of short circuit current. The tubes were filled with 2% Agar-Ringer's solution. One probe contained also  $\text{Na}^{22}$ . All electrical controls were manually operated with a few exceptions. It was found that in intact skin  $\text{Na}^+$  transport, calculated from the short circuit current, exceeded by a factor of 2 or more the  $\text{Na}^+$  transport obtained from  $\text{Na}^{22}$  flux measurements. When the same device was used on isolated skin, the short circuit current was equivalent to  $\text{Na}^+$  flux. The reason for this discrepancy in results when using intact skin are, at present, unclear. The possibility of an  $\text{Na}^{23} \rightleftharpoons \text{Na}^{22}$  exchange or of active  $\text{Cl}^-$  transport in the outward direction is suggested. In the former situation,  $\text{Na}^{22}$  moving in from the epithelial side of the skin may be exchanged for  $\text{Na}^{23}$  of the blood stream, moving out from the dermal side of the skin, thus, in effect, lowering  $\text{Na}^{22}$  flux across the skin.



## EFFECT OF HYDROCORTISONE FEEDING ON SERUM CHOLESTEROL AND TRIGLYCERIDES

J. C. Forbes and O. M. Petterson, *Medical College of Virginia*

The effect of centrifugation at  $20,000 \times g$  on the cholesterol and triglyceride distribution in sera from rabbits on a diet containing cholesterol and hydrocortisone was studied. Three levels of cholesterol were employed: 1, 0.5 and 0.2%. Hydrocortisone concentration was 0.002%. The animals fed the 1% cholesterol plus hydrocortisone diet showed extremely high serum cholesterol and triglycerides, averaging 6000 and 3800 mg per cent respectively. The corresponding controls showed only 2000 mg per cent cholesterol and 210 mg triglycerides. The degree of atherosclerosis in the abdominal aorta was roughly the same in both groups when the animals were sacrificed after 9 weeks. The thoracic aorta, however, showed distinctly less involvement in the hydrocortisone-fed rabbits than in the controls. As the cholesterol content of the diet was reduced the effect of the hydrocortisone on the serum cholesterol and triglyceride diminished but their concentrations always remained much higher than that of the corresponding controls. The protective action of the hydrocortisone also became more definite. For example, when the diet contained 0.2% cholesterol, all of the control animals showed lesions at the end of the experimental period while only one hydrocortisone fed animal showed a lesion and this was animal. It would appear that the physical state of the plasma cholesterol is of greater importance than total cholesterol as far as atherogenicity is concerned.

## THE EFFECTS OF HALOGENATED SALICYLATES ON PULSE RATES OF RATS

C. L. Gemmill and K. M. Browning, *University of Virginia, School of Medicine*

During the study of the effects of halogenated salicylates on metabolism of rats, pulse rates were determined. It was observed that dosages of 5-iodosalicylate and 5-bromosalicylate which caused increments in metabolism did not change the pulse rate. Also, salicylate in dosages which caused increments in metabolism did not produce increment in pulse rate. These observations are in contrast to the usual rise in pulse rate which accompanies the rise of metabolism with thyroxine and 3,3',5-triiodothyronine.

## EFFECT OF QUABAIN AND INSULIN ON POTASSIUM FLUXES IN FROG MUSCLE

Courley, D. R. H., *University of Virginia, School of Medicine*

*Muscle* The unidirectional fluxes of K have been determined in isolated

intact sartorius muscle of the frog by means of  $K^{42}$ . Normally only 60% of the muscle K is exchangeable. Insulin (50 mU/ml) increased the size of the exchangeable K compartment (A) from 46 to 57  $\mu\text{Eq/gm}$  and the K influx from 7.5 to 8.00  $\mu\text{Eq/gm/hr}$ . Ouabain ( $10^{-6}\text{M}$ ) decreased A from 50 to 29  $\mu\text{Eq/gm}$  and influx from 7.8 to 7.2  $\mu\text{Eq/gm/hr}$ . Insulin decreased the efflux of K from a  $K^{42}$ -loaded muscle from 5.7 to 5.0  $\mu\text{Eq/gm/hr}$ , while ouabain increased K efflux from 5.8 to 7.4  $\mu\text{Eq/gm/hr}$ . The data are consistent with the hypothesis that the reaction  $K^+ + X^- \rightleftharpoons KX$  is shifted to the right by insulin and to the left by ouabain (where  $X^-$  is probably a selective polyelectrolyte gel).

#### INFLUENCE OF CORTISONE AND HYDROCORTISONE ON ABSORPTION OF CHOLESTEROL- $C^{14}$

Edwin S. Higgins and John C. Forbes, *Medical College of Virginia*

Mice were fed diets of ground chow which contained 20 mg/kg of either cortisone or hydrocortisone. A third group received chow only. After an overnight fast, each animal was given 9 mg of cholesterol containing 1  $\mu\text{C}$  of either cholesterol-4- $C^{14}$  or cholesterol-26- $C^{14}$  mixed in a 250 mg portion of diet. Under basal conditions blood cholesterol values in the cortisone-fed mice were consistently higher than those of controls. Findings on specific activities and cholesterol contents of blood, liver, and gastrointestinal tracts were in accord with the postulation that glucocorticoids stimulated the intestinal absorption of cholesterol during the first 6 hours. Effects of hydrocortisone were in the same direction, though less marked, than those of cortisone. Serial collection of fecal material yielded additional evidence establishing the general conclusion that glucocorticoids increase intestinal absorption of cholesterol.

#### PATHWAY OF GLUCOSE METABOLISM IN BRAIN AND INFLUENCE OF ETHANOL ON GAMMA-AMINOBUTYRIC ACID CONTENT

Edwin S. Higgins, *Medical College of Virginia*

It was demonstrated that the magnitude of the phosphogluconate pathway in rat brain is insignificant under normal aerobic conditions and also under conditions of ethanol intoxication. Ethanol depressed the content of gamma-aminobutyric acid (GABA) in the brain of the Sprague-Dawley rat but had no influence on the pathway of glucose utilization. Vitamin  $B_6$  deficiency produced a marked depression in GABA levels but these were not further depressed by ethanol. Although the GABA shunt has obviously important metabolic implications in brain, it appears to have little quantitative significance under conditions of vitamin  $B_6$  deficiency since the depressant action of ethanol was not manifest.

## EFFECT OF X-RAYS ON ENZYMES

L. A. Mounter, *Medical College of Virginia*

Changes in physical and kinetic properties as a result of irradiation of dilute aqueous solutions of enzymes have been reported from several laboratories. Investigations in this laboratory of the effects of x-irradiation on a number of hydrolytic enzymes have shown that it is possible to produce alterations in the relative rates of hydrolysis of different substrates which can be interpreted as changes in specificity. Kinetic differences between samples of control and irradiated cholinesterases may be comparable to species-specificity differences in the enzymes derived from different sources. Alterations in enzymes as a result of x-irradiation which do not involve complete loss of function have been observed in several systems and these results may be of significance in contributing to an understanding of the interactions between enzymes and their substrates.

## SPECIFICITY OF ELECTRIC ORGAN CHOLINESTERASE

Mary-Elizabeth Mounter, Rita M. Cheatham, and L. A. Mounter, *Medical College of Virginia*

The substrate specificity pattern of electric organ cholinesterase has been determined for a number of choline and noncholine esters. The experimental conditions used were the same as those employed in previous specificity studies of this type. It was found that there are only minor differences in specificity between the acetylcholinesterases of erythrocytes, brain, cobra venom and electric organ. The results are discussed with respect to the factors which govern the mechanism of action and substrate specificity of hydrolytic enzymes and the possibility of effecting changes in enzymic properties by physical and chemical means.

## EFFECT OF 17-ETHYL-19-NORTESTOSTERONE ON BLOOD GLUCOSE IN THE ALLOXAN DIABETIC RAT

John A. Thomas, *University of Virginia, School of Medicine*

Glucagon-induced hyperglycemia can be modified under a variety of conditions. Experimental diabetes, orchidectomy, administration of dichloroisoproterenol and various steroidal agents alter an animal's responsiveness to exogenous glucagon. Animals rendered alloxan-diabetic and then orchidectomized, exhibit an exaggerated blood glucose response five days post-operatively when injected with 0.1 mg/kg of crystalline glucagon. A refractoriness under these same experimental conditions was noted at later post-castration intervals, namely at the 20th and 25th days. When the



experimental animals are treated with 17-ethyl-19-nortestosterone (.17 mg daily x5) or with estradiol benzoate (1.0 $\mu$  gm daily x5) suppression of glucagon-induced hyperglycemia was observed.

#### STUDIES OF PROTEINS OF BONE

H. G. White, Jr., Herman M. Nachman, and E. R. Berry, *Medical College of Virginia*

Preliminary investigation of an *in vitro* method of extracting protein from bone under optimum physiologic conditions is reported. By exposing specially prepared samples of bone to partial pressures of carbon dioxide for varying periods of time, protein substances were **extracted from** bone. The rate of release of the protein substances was measured by the amount of Kjeldahl nitrogen released into the reaction mixture. The protein substances present in the reaction mixture were analyzed by an agar gel micro-electrophoresis technique. The results thus far indicate that protein substances are being extracted from bone *in vitro* under optimum physiologic conditions.

#### A BROAD RANGE MICRO-SPECTRODENSITOMETER FOR AGAR ELECTROPHORESIS

R. C. Williams, R. S. Ruffin, and E. R. Berry, *Medical College of Virginia*

A densitometer has been constructed for analysis of agar electrophoresis patterns. Features included are: Wavelength range 250 – 700 m $\mu$ , overall stability including long term drift, noise, etc.  $\pm$  500  $\mu$ v on the 125 millivolt full-scale range. Crossed slits provide scanning slit width variable from 0 – 2 mm and slit length from 1 – 5 mm. A Bausch and Lomb rectangular microscope stage is synchronous motor driven and accommodates microscope slides up to 5 x 7 cm. A photomultiplier tube, 1P28, is used as the detector; the tube current being measured by a recording potentiometer. A chopper stabilized lamp power supply has been **designed** which holds the lamp voltage within  $\pm$  1 millivolt. Precise reproducibility demonstrates excellent sensitivity and stability.

### SECTION OF PSYCHOLOGY

R. A. Johnston, *Chairman*

E. Rae Harcum, *Secretary-Treasurer*

F. B. Rowe, *Section Editor*

#### MINUTES

The meeting was called to order at 4:45 p.m. by the Chairman, Dr. Robert A. Johnston.

The minutes were read by the Secretary-Treasurer and approved as read; balance in the treasury is \$4.10.

Dr. Johnston led a group discussion in which the consensus of opinion was that the annual Section program should include invited, informal speeches, and that it should allow more time for individual speakers on the symposia.

The problem of advancing the study of psychology among high-school students was discussed. It was moved, and seconded, that the Executive Committee be instructed to go to the State Board of Education, with the offer to assist in the evaluation of high-school courses in Psychology. The motion was unanimously approved.

Dr. Johnston appointed Dr. William M. Hinton to be the Historian of the Section, to serve as long as he would wish to serve.

The report of the nominating committee, Drs. Grigg, Hinton, and Reid, was read. The nominations were: Dr. Robert A. Johnston, Chairman; Dr. E. Rae Harcum, Secretary-Treasurer, and Dr. Leonard Jarrard, Executive Committeeman. The adoption of the slate was moved, and seconded. The motion passed unanimously.

It was noted that Dr. Williams' term on the Executive Council had not expired, and that Dr. F. B. Rowe had been appointed as Section Editor to the *Virginia Journal of Science*.

It was moved, and seconded, that the meeting be adjourned. The motion passed without dissent.

E. Rae Harcum, Secretary-Treasurer

#### THE RORSCHACH AND THE MMPI: A CONCURRENT VALIDITY STUDY

Henry B. Adams, *VA Hospital, Richmond*; G. David Cooper, *Petersburg Training School*, and Richard N. Carrera, *Emory University*

Klopfer's Rorschach Prognostic Rating Scale (RPRS) has been shown to be more sensitive than any "traditional" methods of Rorschach scoring to the most essential aspects of effective personality functioning, i.e., reality testing, emotional integration, self-realization, and mastery of reality situations. Rorschach protocols on 36 psychiatric patients were scored for the RPRS. These scores were then correlated with all scales of the Minnesota Multiphasic Personality Inventory, plus the Welsh A and R Scales and the Barron *Es* Scale. It was predicted that the RPRS would be correlated negatively with the MMPI clinical scales and Welsh's A and R scales, and positively with Barron's *Es* scale. Every correlation between

over-all RPRS scores and the MMPI scales fell in the predicted directions ( $p < .001$ ).

An extreme groups comparison was made of the MMPI profiles of subjects scoring highest and lowest on the RPRS. The high RPRS group differed from the low group in directions indicating more effective functioning on all scales ( $p < .001$ ). Mean profiles of the two groups were graphically plotted and presented to ten clinicians, each being asked to choose the profile showing the more favorable prognosis for psychotherapy. All agreed that the high group showed a better prognosis ( $p < .001$ ). The clinical judgments supported Klopfer's description of the RPRS as a measure of prognosis for psychotherapy.

#### THE PERSERVATION OF TRACES IN THE TACHISTOSCOPIC RECOGNITION OF WORDS

John J. Baldino, *The College of William and Mary*

Forty Os were shown tachistoscopically a list of eight-letter nonsense words in which one critical word was repeated a second time. The threshold for each word was determined by the method of limits, using duration as the dependent variable. The Os were assigned equally to five conditions, wherein either zero, one, two, four, or eight words intervened between the two threshold determinations of the critical word. In addition, by instructions a specific set against seeing the same word twice was given to each O.

For 33 of the 40 Os the threshold was lower on the second threshold determination, with the amount of decrement generally smaller with the greater number of intervening words.

The results are not consistent with expectation theory which would hypothesize an increase in threshold, but rather support a theory of a short-term memory-trace, which dissipates with time and with a greater number of intervening stimuli. This perseveration of a trace in the central nervous system as a result of the first presentation of the critical word, appears to serve as a kind of "priming mechanism", which facilitates the reactivation of the trace.

#### THE EFFECT OF PRETRAINING AND KNOWLEDGE OF RESULTS ON THE ACQUISITION OF PAIRED-ASSOCIATES

H. Ray Brackett, *University of Virginia*

The present experiment was performed to evaluate the effect of method of learning and knowledge of results within the classic Rock paradigm. This was accomplished by pretraining Ss in one of two methods. A *whole pretraining* group received pretraining by learning two lists of shape-num-



ber pairs to a criterion of one errorless trial after being instructed to concentrate on learning all the material presented on each trial. The Ss of a second *part pretraining* group only learned portions of six separate lists, each to a criterion of four out of twelve correct responses. On Day 2 following the pretraining of Day 1, half of each group learned a list of paired-associate nonsense syllables by the repetition procedure, the other half learned by the non-repetition procedure. Half of the Ss under both repetition conditions within both *part* and *whole pretraining* were given knowledge of results, the other half of the Ss were given no knowledge of results. All measures of performance agreed in demonstrating that (a) the repetition procedure is significantly superior to the non-repetition procedure under the *whole pretraining* condition, (b) under the *part pretraining* condition, there are no differences in performance between the repetition and non-repetition conditions, and (c) the knowledge of results variable had no significant effect on performance under any of the experimental conditions.

#### THE INFLUENCE OF FREQUENCY OF THE IDENTIFICATION OF AMBIGUOUS FORMS

James H. Brown, *University of Virginia*

Both high and low-frequency effects have been found in responses to stimuli rendered ambiguous by several different procedures. Typically, it has been found that low-frequency responding is related to "unfamiliar" stimuli in a separated training and test paradigm. High-frequency responding is evident in responses to more familiar stimuli in a separated training and test paradigm and to both familiar and unfamiliar stimuli when training and test are combined into a single session. The explanation of these results across a number of studies would seem to rest with the quite different reinforcement contingencies exerted by the two situations.

#### THE EFFECT OF VARIOUS EVENT RUN LENGTHS ON HUMAN BINARY PREDICTION

Peter L. Derks and Lois Gurnee Blanchard, *The College of William and Mary*

The response distributions of 40 probability matchers on 4 different stochastic binary schedules were examined. Although Ss' predictions did not seem to follow the schedules directly, increases in certain event runs were reflected in corresponding increases in prediction runs.

In a second experiment 60 S's did not increase  $E_1$  predictions whether they predicted a schedule with long or short event runs. However, sched-

ule run length influenced both prediction distribution and the prediction of an event after its successive occurrences. These results suggest that binary prediction is a function of event runs in a binary schedule rather than single event probability.

#### TACHISTOSCOPIC RECOGNITION OF WORDS AND THEIR MIRROR IMAGES

Mary Ellen Finkel and E. Rae Harcum, *The College of William and Mary*

Mishkin and Forgays (1952) found that English words were perceived more accurately when they were presented tachistoscopically to the right as compared to the left of a fixation-point. However, their bilingual Os could recognize Hebrew words presented to the left of fixation more accurately. In the present study, meaningful English words and left-right mirror-images of meaningful English words were presented tachistoscopically to the left and right of fixation. Whereas the words presented in the normal orientation were more accurately perceived when they appeared to the right of fixation, the words reversed in orientation were more accurately perceived when they appeared to the left of fixation.

Results are interpreted as providing evidence for a sequential visual process, the beginning and end of which is determined in part by characteristics of the stimulus-pattern. If directional aspects of the visual pattern tend to produce a sequential process proceeding toward fixation rather than away from it, then a conflict with the directional tendency to read from fixation toward either edge of the visual field apparently occurs—and perception is hindered.

#### THE EFFECTS OF TRAINING IN COMMUNICATION AND ROLE PERCEPTION ON THE COMMUNICATIVE ABILITIES IN CHILDREN

Charles Luther Fry, Jr., *University of Virginia*

This research attempted to examine the effects on subsequent communicative abilities of special training which emphasized the necessity of accounting for the role of the listener in effecting adequate transfer of information in communication.

The training procedure used many series of pictures and required speakers to communicate to listeners so that the listeners could correctly identify a particular picture in the series. Training took place in groups of four, and speakers received feedback about the success of their communications by observing listeners attempting to make this identification. The subjects were 64 fifth grade girls of above average I.Q. Of these, 16 trained as speaker only, 16 as listener only, 16 trained alternately in each role, and 16 were controls and had no training. Tests were administered both

before and after training, and the pretest to posttest improvement was compared for the various groups both in training task specific and generalized communication improvement.

There were three hypotheses. The first suggested that training would bring about communicative improvement in situations similar to the training procedure. This was supported. The second suggested that this improvement would generalize to other less similar communication situations. The results here were not clear cut and further research was suggested, but this hypothesis did find some support. The third suggested that the three training conditions would not be equally effective in bringing about communicative improvement. This was not supported.

#### SERIAL ROTE LEARNING AS A FUNCTION OF RATE OF PRESENTATION AND OVERT ERRORS

John P. Harcourt and Milford F. Schwartz, *Washington and Lee University*

In an early study by Scheible and Underwood it was found that no significant differences existed in relative number of trials to criterion in learning a serial list of nonsense syllables under the following conditions: (1) a high error or "forced" group where subjects were told they had to guess at the next syllable, (2) a low error or "voluntary" group where subjects were told not to respond unless positive of the correct syllable, and (3) a control group where the subjects were told neither that they must nor must not guess. Underwood and Scheible used a 2-sec. inter-syllable interval. It was hypothesized that a faster rate of presentation would inhibit learning because much of the subjects' processing time would be used in vocalization. It was further hypothesized that a slower presentation rate in the high-error group would have the effect of facilitation, for the subjects would be forced to guess, but not at an inhibiting rate.

One hundred and sixty-two Ss were randomly divided into nine groups. There were two main variables: (1) rate of presentation, divided into three groups of 1.5", 2.0" and 6.0", and (2) instructions, composed of the high-error, low-error, and control groups. It was found that there is no relationship between rate of learning serial nonsense lists and number of overt errors made in learning those lists. The results also show that variation of rate of presentation, while it does produce more errors per trial and a significant difference in number of trials to learning, has no significant interaction effect with instructions.

#### THE EFFECT OF VARIED AND CONSTANT DRINKING LOCATION ON ACTIVITY AND EXPLORATION IN THE RAT

George J. Igel and James H. Woods, *University of Virginia*



An attempt was made to manipulate the rat's history of water-attaining responses in its home cage in order to explain why the rat responds differently to water deprivation than to food deprivation. Groups of rats were raised from weaning to maturity with different water-attaining experiences. At maturity all animals were subjected to 48 hours of water deprivation and tested in three separate apparatuses. The results indicate that the previous history of water attainment did not distinguish the groups during the water deprivation period.

#### TRANSFER OF CLASSIFICATION AND IDENTIFICATION EXPERIENCE TO THE RECOGNITION OF RANDOM SHAPES

Russell B. Johnson, *University of Virginia*

An experiment was conducted to determine the effects of a verbal pre-training task upon performance in a subsequent recognition test.

The principal findings of the recognition test were: (a) performance was primarily determined by the type of stimulus forms used during training, with Ss who had been presented dissimilar forms being superior in terms of recognition accuracy; (b) frequency of presentation was revealed to have both an independent and an interactive effect with the type of stimulus upon most of the recognition measures; and (c) none of the recognition test measures was related to the kind of responses used during labeling practice.

The results were interpreted in terms of Bruner's concept of "category accessibility".

#### A STUDY OF MAGNITUDE OF ERRORS ON THE PURSUIT ROTOR

George W. Kent, *Bridgewater College*

The purpose of this study was to examine behavior changes during pursuit rotor learning other than those measured by the traditional time-on-target measure.

Fourteen subjects were divided between massed practice and distributed practice conditions. An error recording pursuit rotor was used which detected angular errors by sensing intensity differences between light falling from an illuminated stylus on two adjacent photocells. The resulting voltage differences were recorded on an ink-recording potentiometer.

The learning process was studied by the following dependent variable measures: total time-on-target; mean magnitude of errors; distribution of error magnitude; and distribution of "hit" durations. Mean error magnitude showed greater differences between massed and distributed groups

than the traditional time on-target measure. Both mean error magnitude and "hit" duration measures showed systematic changes not revealed in total time-on-target results.

It was concluded that these error and hit measures were potentially valuable in studying pursuit rotor performance, particularly in detecting behavioral changes not revealed by the total time-on-target measure.

#### THE SENSITIZATION-REPRESSION DIMENSION AS RELATED TO DEVIANT RESPONSES ON CONTENT AND CONTENTLESS TASKS

A. W. Lucky, *University of Richmond*

Male and female college students were administered the Byrne Repression-Sensitization Scale, a self-description adjective check list, and a number task with an ESP set. The order of administration was varied. It was hypothesized that those who gave deviant responses on a self-description (content) task would more likely be sensitizers (intellectualizing, obsessional type) than repressors (denying, repressing type), whereas on a non-self-description (contentless) task there would be no difference.

A significant difference between sensitizers and repressors ( $r = .40$ ,  $p < .01$ ) was found, thus verifying the first hypothesis. No difference ( $r_p = .07$ ) was found between sensitizers and repressors for the contentless tasks as predicted, but the small number of deviant responses (13) makes this measure unreliable. Since no differences were found that could be accounted for in terms of sex or order of administration, the scores were combined.

#### CONSTANT VS. VARIED SERIAL ORDER IN PAIRED-ASSOCIATE LEARNING AND RETENTION

Douglas L. Nelson, *University of Virginia*

Paired-associate learning and retention of a ten-item nonsense syllable list was compared under two conditions: (1) a constant condition, where all syllables are presented in the same order on every trial and (2) a varied condition, where the syllables are unsystematically varied from trial to trial. Under the recall method, in which presentation of all the stimulus-response pairs is followed by the stimulus terms alone, no significant differences in learning were found between the constant and varied groups. Twenty-four hours later, however, the varied group was significantly superior to the constant group as measured by several types of retention tests.

## FEMALE MASTURBATION AND MARITAL HAPPINESS PREDICTION

William R. Reevey, *Northern Virginia Mental Health Project*

One hundred and thirty-nine female volunteers of approximately mean age 20 years, 8 months, were interviewed and questioned about their masturbatory experiences and certain attitudes and feelings related to masturbation. After the data gathered by means of the interview were compiled, the responses of the 87 girls who scored at the 73rd percentile or above on the Happiness Scale of the Adams' Marital Happiness prediction test were contrasted with those of the 52 girls who scored at the 23rd percentile or below as to whether or not they had masturbated. It was found that approximately the same proportions of individuals in each group had a history of masturbation, yielding no significant difference between the groups. The 27 high scoring girls (31% of the total) and the 24 low scoring girls (46.2% of the total) who had masturbated were further questioned about the techniques which they had employed. Statistically significant differences were found between the two sub-groups on five responses. The group with unfavorable marital happiness predictions can be characterized as more alert to the orgasmic possibilities of various techniques of masturbation. For a significantly greater proportion of this group has used the following techniques: (1) manipulation of the vagina, (2) clitoral stimulation, (3) vaginal insertions, and (4) thigh pressure. It was found, also, that a significantly greater proportion of this group said that masturbation relieved tension.

The groups are not differentiated in their use of other techniques, such as (1) breast stimulation, (2) rubbing the vaginal area against objects such as the arm of a chair, and (3) "other techniques" as a separate miscellaneous category.

## THE EFFECTS OF VARIOUS SCHEDULES OF REINFORCEMENT ON TWO-CHOICE BEHAVIOR IN HUMAN SUBJECTS

George J. Skrzypek, *The College of William and Mary*

Maier (1949) has advanced the hypothesis that one consequence of frustrating an organism is the establishment of abnormally rigid, non-adaptive and non-goal oriented behavior. Marquart (1948) and Marquart and Arnold (1952) have attempted to show that Maier's frustration-fixation hypothesis is applicable to human subjects, with results favoring this hypothesis. The present study compared the number of trials required to solve a new problem following original problem situations in which a solution was or was not possible.

Forty college students were assigned to one of four groups. The three



experimental groups were put on 25%, 50% and 75% schedules of arbitrary punishment in an insoluble task. A control group was given a simple learning task. As punishment for the experimental groups increased from 25% to 75%, the median number of trials required to learn the subsequent simple task decreased from 63.5 to 29. The control group and the 50% arbitrary punishment group learned in 45 and 50 trials respectively. Although these differences were not statistically significant, they indicate an interesting trend which is opposite to the conclusions of Maier, Marquart, and Marquart and Arnold.

#### THE LACK OF AGREEMENT BETWEEN M-F-D TEST SCORES AND PSYCHIATRIC DIAGNOSES

Bessie S. Smith, *Lower Peninsula Mental Hygiene Clinic*

During 1960 all patients over 8½ years of age scheduled for psychological examinations at the Lower Peninsula Mental Hygiene Clinic were given the Memory-for-Designs Test. Test was administered and scored according to the revised general manual of 1960. Scores were corrected for age and intelligence by tables provided in the manual. No attempt was made to control factors such as race, sex, education, and occupation, considered irrelevant variables in the monograph report.

As the number of cases diagnosed in the clinic as brain-damaged has been small, ranging from 4 to 16 in the past four years, and since psychiatric diagnosis was to be the criterion, the chief interest of this research was in the frequency of false positives or to test the authors' conclusion that, with a poor score, there is a high probability of brain disorder. Test scores classified 21 cases as brain-damaged and 29 as borderline. Nineteen of the 159 records, still undiagnosed, include only six possibilities of agreement between borderline or organic test scores and a psychiatric diagnosis of brain damage. Of the 140 completed diagnoses, only three are in the brain-damaged category.

#### EFFECTS OF D-LYSERGIC ACID DIETHYLAMIDE ON FOOD CONSUMPTION IN THE RAT

Donald A. Stubbs, *Washington and Lee University*

In a previous study that was performed on the effects of different doses of LSD-25 on operant conditioning in the rat, it was found in a food reward situation (VI 2 min.) that rats receiving 0.05 mg/kg responded more during the first 30 min. after injection than they did after a control injection. When the Ss received 0.40 and 0.80 mg/kg, they responded less than with a control injection. A question was raised concerning the results of the 0.05 mg/kg dose. Was the increase in respond-

ing due to central stimulation which caused an increase in bar pressing, or did the drug simply increase motivation? To answer this question a food consumption study was performed using the same levels of LSD-25 as those used in the previous study. The animals were given free access to food for a 2-hr. period every day for 50 days. Then, injections were given every fourth day in a counterbalanced order to the 12 Ss. The results indicated that less food was eaten during the first half hour for all doses except the 0.05 mg/kg dose. The 0.05 mg/kg dose did not result in significantly different eating from the control injection. Thus, it was concluded that the small dose acted as a central stimulant rather than serving to increase eating behavior.

#### TIME-OUT FROM POSITIVE REINFORCEMENT

Don Thompson, *University of Virginia*

When a rat can itself impose extinction during fixed-ratio water reinforcement, the frequency of the extinction periods is found to be an increasing function of the number of responses required for reinforcement. Also, the frequency of "time-outs" increases with decreases in deprivation. Typically, the time-out period occurs at the start of the usual fixed-ratio run. However, under mixed reinforcement contingencies, "time-outs" occur during the higher ratio component only after the lower ratio is completed. It is suggested that escape from the  $S^D$  control, during a certain stage within the inter-reinforcement interval, is reinforcing.

#### OPERANT CONDITIONING AND FOOD CONSUMPTION AS INDICANTS OF THE EFFECTS OF X-IRRADIATION ON RATS

Walfred B. Thulin, *Washington and Lee University*

This experiment was designed in response to Russian claims of behavior changes, learned and unlearned, due to very small amounts of irradiation.

The subjects were 48 male albino rats between the ages of 90 and 100 days that were trained in operant conditioning situations. Half were trained using a Skinner box with food reward (VI 2 min.) and half were trained with a Sidman shock-avoidance procedure (SS 20" RS 20"). Each group was further divided into four sub-groups that included a control group and three experimental groups (100r, 300r, and 500r). After the animals were well trained, they were irradiated using a 250 kv therapy unit. Performance was recorded for 14 days post-irradiation. In addition, a separate food consumption study was run.

An analysis of variance performed on the data failed to support the Russian claims. No significant differences were found after irradiation for animals in the avoidance situation. However, there were significant

differences in the animals pressing for food. The analysis revealed a Treatments-by-Days interaction. Subjects receiving 300r differed from the control group for one day and the 500r group for 4 days. The most sensitive measure of irradiation effects however proved to be those which were unlearned. The food consumption study indicated that the 100r group ate significantly less than the control group for one day, and the 300r and 500r groups ate less for five days. Food consumption was affected more than the bar pressing behavior of the Ss working for food. Thus, it is concluded that amount of food eaten was the most sensitive measure of irradiation exposure.

#### THE EFFECT OF FIELD ILLUMINATION UPON EXPLORATORY BEHAVIOR IN THE RAT

Wesley C. Westman, *The College of William and Mary*

Twenty female albino rats were given one 30 min. trial on a 4 ft. x 8 ft. checkerboard field. Half of the trial (15 minutes) was given under normal room illumination and the other half under bright light from one 1000 watt bulb. Under normal illumination the mean number of squares entered was 36.9, and the mean for bright illumination was 3.75. These data are significant well above the .001 level of significance ( $t=9.45$  with 19 df).

The results support the hypothesis that rats show significantly less exploratory behavior under conditions of bright illumination even though they are in a novel environment.

#### THE EFFECTS OF CAFFEINE AND SODIUM SECONAL ON OPERANT BEHAVIOR IN THE RAT

Clarence M. Whitehead, Jr., *Washington and Lee University*

Caffeine and secobarbital sodium were tested for their effects in two operant conditioning situations. Dose-response and time-response relations for the drugs were determined. The Ss consisted of 12 male, albino rats. They were run for 2 hour sessions each day in 2 Skinner-type boxes with one box set up for the Sidman shock avoidance procedure (SS10" RS10") and the other one for food reinforcement on an aperiodic schedule of reinforcement (VI 2 min.). The following 12 intraperitoneal injections were given each animal: 2 saline control injections, 5, 10, 15, 20, and 25 mg/kg of seconal, and 10, 20, 30, 40, and 50 mg/kg of caffeine. The order of drug administration was counterbalanced.

In the shock situation, caffeine in the two smallest doses increased bar pressing but the larger doses were similar to the effects of the control



jection. For seasonal increasing doses of drug generally increased number of shocks, decreased number of bar presses, and had a longer depressive effect. In the food situation, caffeine did not increase the number of bar presses; however, seconal showed a decrease in number of bar presses with increasing doses of the drug. It seems that seconal is a good depressant to use in future learning studies; but caffeine did not stimulate bar pressing in both shock and food situations.

#### THE EFFECT OF PRONUNCIABILITY, FAMILIARITY, AND MODE OF PRESENTATION ON ACQUISITION OF CVC TRIGRAMS

John M. Williams, *The College of William and Mary*

Will aural and visual presentation methods give varying rates of learning depending on the pronunciability of the material to be learned? Other studies have shown pronunciability to be a factor governing ease of learning and different modes give different amounts of aid to pronunciation.

Ninety subjects each learned one of three lists: 1) low pronunciability, 2) high pronunciability, and 3) three letter words. Each list was presented by three methods: 1) visual, 2) auditory, or 3) combined simultaneous aural-visual, each S learning by only one method. The lists were learned by the paired associate method to a criterion of two perfect recitations or 12 trials.

Nonsense syllables with high pronunciability were learned faster than low pronunciability syllables; except when presented aurally. The high pronunciability syllables were also learned faster when presented by the visual or combined method than when presented by the auditory method.

Three letter words were learned faster than high pronunciability syllables when presented aurally or visually. They were also learned better by the combined method than by the auditory method. Combined presentation showed a nonsignificant advantage on all three types of material.

Pronunciability is an important factor when learning nonsenses syllables presented visually, but not when learning syllables which are presented aurally.

#### MODIFICATIONS IN THE RAT'S DIURNAL BEHAVIOR AS A FUNCTION OF QUININE CONCENTRATION IN A LIQUID DIET

John H. Wright, *University of Virginia*

Two groups of 6 male albino rats were given food containing quinine hydrochloride during the dark hours of the 24-hr. day for 50 days. One group received a 0.50% concentration, the other group a 0.10% concentra-

tion of quinine in its nightly food. The food during the light hours contained no quinine for either group. Dark-hour intake was depressed by the quinine, the amount of depression being greater for the group receiving the heavier quinine concentration. Accompanying this decrease in dark-hour intake was an increase in light-hour intake, this increase being a function of the amount of dark-hour intake depression produced by the quinine. During the dark hours the group which ate more ran more in the activity wheel; the other group, which ate more during the light hours because of its greater deficit accumulated during the dark hours, tended to run more during the light hours. These results are consistent with the hypothesis that eating reinforces running.

#### SYMPOSIUM ON "IMPLICATIONS OF THE JOINT COMMISSION REPORT FOR PSYCHOLOGY"

Chairman Harold M. Hildreth, N.I.M.H.

Manpower Availability and Needs: Austin Grigg, University of Richmond

Implications for Training in Psychology: A. W. Jeffries, Western State Hospital

*Implications for Practice in Various Settings*

1. Clinics-Hospitals: Cyril R. Mill, Va. Dept. of Ment. Hygiene and Hospital

2. Schools and other settings: Cletus A. Cole, Arlington County Public Schools

Implications for Research: Edwin S. Zolik, Northern Va. Ment. Health Project

Implications for Interdisciplinary Relationships and Efforts: Nathan Altschuler, Department of Anthropology, The College of William and Mary

#### THE CONCEPT OF DRIVE

Audience-participation discussion.

Stanley B. Williams, *Chairman*, The College of William & Mary; Robert A. Johnston, University of Richmond; and L. Starling Reid, University of Virginia.

#### SYMPOSIUM ON CONSUMER-PRODUCER EXPECTATIONS IN PSYCHOLOGY

Neil W. Coppinger, *Chairman*, V. A. Center, Kecoughton; Edwin S.

Zolik, Northern Virginia Mental Health Project; Cyril R. Mill, Virginia Department of Mental Hygiene & Hospital; John J. McMillan, Medical College of Virginia; Louis D. Cohen, Duke University Medical School; and Frank W. Finger, University of Virginia.

## SECTION OF SCIENCE TEACHERS

R. Horn, *Chairman*

Mrs. G. T. Thaxton, *Chairman-Elect*

Mrs. V. Remsburg, *Secretary*

A. Mandell, *Section Editor*

### MINUTES

The Science Teacher's Section of the Virginia Academy of Science met in room 800-801 at the Golden Triangle Hotel, Norfolk, Virginia, with Norfolk College of William and Mary serving as host.

The meeting was opened by the Chairman, Mr. Robert Horn at 2:00 P.M. The program consisted of two papers, Functional Vs. Classical Biology and the Placement of Biology in the High School Curriculum by John G. Barker, Head of Biology Department, Radford College. (An abstract of this paper is attached to this report). The second paper was given by Miss Samulella Crim, Glassboro State College, N. J. This paper was on the History of the Section of Science Teachers.

During the business meeting the following new officers were elected.

Chairman — Mrs. Joe Thaxton Jr.

Chairman-Elect—Mr. John E. Reitz

Secretary — Mrs. Vera B. Remsburg (1960-63)

Section Editor — Mr. Alan Mandell (1960-63)

Council Member — Miss Susie Floyd (1960-65)

The committee investigating the possible listing of scientists available to help students and secondary school science teachers reported no progress. The committee was therefore dissolved. The incoming chairman appointed Mr. John Reitz membership chairman. Mr. Reitz was to form his own committee in an effort to increase section membership. Mr. Frank Kizer, State Supervisor of Science, made a motion that all present members make an effort to increase section membership, and suggested certain ways to accomplish this goal.



FUNCTIONAL VERSUS CLASSICAL BIOLOGY AND THE PLACEMENT OF BIOLOGY  
IN THE HIGH SCHOOL CURRICULUMJohn G. Barker, *Radford College*

Recent events have caused us to re-examine our instruction in the sciences. Exposed weaknesses are being subjected to remedial efforts. High school science instruction has two objectives of equal importance. We must identify and stimulate the development of the potential scientist, and we must acquaint all others with the nature and concepts of science in order that they may provide an environment in which science will progress.

A serious division has developed in biology. The traditional biology teacher emphasizes classification and structure, whereas the modern biologist emphasizes the physico-chemical attributes of life. As a result the former may require rote learning of static details, the latter may fail to extrapolate from cellular minutiae to the level of the organism.

We need not choose one or the other, but we must seek by every means available to reduce the widening gap between these extremes. The following measures are recommended:

1. The adoption of more stringent requirements for teacher preparation and re-education.
2. Modernization of facilities and procedures.
3. Minimizing of fact-learning by teaching concepts supported by enough detail to lend vitality
4. Articulation of high school biology with modernized programs of science in junior high and elementary schools.

## SECTION OF STATISTICS

Miss E. Angle, *Chairman*J. M. Long, *Vice Chairman*R. J. Freund, *Secretary*C. Y. Kramer, *Section Editor*

## MINUTES

The meeting was called to order by Miss Elizabeth W. Angle. The nominating committee presented their nominations for the 1962-63 Section officers. These nominations were subsequently voted into office as follows: J. M. Long, Chairman; V. Chew, Vice Chairman; W. L. Johnson, Secretary; C. Y. Kramer, Section Editor; B. Harshbarger, Historian.

## INFERENCE ON A GENETIC MODEL

J. J. Bartko, *Virginia Polytechnic Institute*

This paper deals with a population genetic model of the Markov chain type introduced by Moran (*Proc. Camb. Phil. Soc.* 54, 1958). In particular, inference is made on a mutation rate of the model where the corresponding Markov chain is absorbing. The transition matrix thus contains an absorbing state. A postulated theorem on the distribution and properties of the maximum likelihood estimate of the mutation rate parameter is presented. A simulation study performed on the IBM 650 substantiates many of the theoretical results and assumptions of the theorem.

## ESTIMATION OF THE STRENGTH OF A RADIOACTIVE SOURCE

Kimiko O. Bowman and H. A. David, *Virginia Polytechnic Institute*

The paper deals with the estimation of the strength of a radioactive source when decay is rapid so that the usual assumption of a Poisson distribution of counts is not applicable. Two main cases are distinguished according as the background radiation is small or large.

SOME STATISTICAL APPLICATIONS AT THE U. S. NAVAL WEAPONS  
LABORATORYVictor Chew, *U. S. Naval Weapons Laboratory, Dahlgren, Virginia*

Four typical applications of statistics were chosen for discussion. A sorting problem from the Computation Division was reduced to the following urn model. An urn contains  $n$  red and  $(N-n)$  blue marbles. Samples of  $n$  marbles each are taken in succession until all  $n$  red marbles have been drawn. The distribution of the number of samples required was derived. For the Astronautics Branch, approximate univariate and multivariate tests were constructed for testing the hypothesis that the unit angular momentum vector of an artificial earth satellite was equal to some postulated unit vector. The Operations Research Branch required the distribution of the negative binomial variable with probability of misclassification. Suppose missiles are fired sequentially at a target until  $r$  hits have been reported. Results were derived for the distribution of the number of missiles required and also for the probability that a target did receive  $r$  or more hits if  $r$  hits were reported. Finally, a bi-response regression problem from the Cartridge Division was considered. Let  $y$  and  $z$  be two response variables, assumed to be linearly increasing functions of some independent variable  $x$ . We require the value of  $x$  which will maximize the probability that  $y$  will exceed some postulated value  $Y$  and

simultaneously  $z$  will be less than some value  $Z$ , assuming that the conditional distribution of  $y$  and  $z$  for any given value of  $x$  is that of the general bivariate normal.

## DESIGNS FOR BLOCKS OF SIZE TWO

H. A. David, *Virginia Polytechnic Institute*

When  $n$  objects or treatments are to be compared in pairs it may not be practicable to make all possible  $N = \frac{n}{2}$  comparisons. Elementary number theory is used as an aid in the construction of suitable designs corresponding to various fractions of  $N$ .

## IMMUNOLOGICAL STUDIES OF ANTHRAX.

### I. AN INDEX TO DETERMINE QUANTITATIVE IMMUNIZATION

DeArmon, Ira A., Jr., *U. S. Army Chemical Corps, Army Chemical Center, Maryland*

Immunized and nonimmunized guinea pigs, rats, and mice given graded challenge doses of *Bacillus anthracis* spores were compared. The reciprocal of time-to-death was found to be linearly related to  $\log_{10}$  challenge dose over a reasonable range of doses, and therefore a difference in position of the parallel regression lines represented a difference in response of control and immunized animals. This difference in position of regression lines is the increase in dose required to cause the immunized group to give the same response as the control. This increase expressed as powers of 10 is called the mean Immunity Index. The mean index of an immunized population of guinea pigs was 3.2, while that for immunized populations of mice and rats was 0.3. Thus, it was concluded that quantification of immunity through this index is possible since the index size follows the general expected qualitative responsiveness of these species. The distributions of response in the immunized guinea pig population was observed to be greater than that for the control population but due to the overlap of these distributions on the index scale, it was hypothesized that only about 46 percent of the immunized populations had a significant protection against *B. anthracis* challenge.

## THE UNWISDOM OF TREATING THE "WORST"

S. Eisenhart and Mary C. Croarkin, *National Bureau of Standards Washington, D. C.*

Let  $n=2m$  objects be subjected to a pre-test, and let the  $m$  lowest



ranking objects be designated for subsequent *treatment* with the remaining  $m$  set aside to serve as *controls*. If the  $2m$  objects are really identical with respect to the characteristic measured, their ranking on the pre-test being solely the result of errors of measurement, and if the experimental data yielded by the pre-test and by a re-test after treatment are analysed in the customary manner (without explicit allowance for the fact that the 'worst' were selected for treatment), then the probability is large of declaring that treatment applied is effective not only when it has absolutely no effect whatever but also when it has a detrimental effect. For example, if there are 5 objects in each group ( $n = 2m = 10$ ) and the significance of the difference of the mean differences,  $\bar{d}_t - \bar{d}_c$  is tested by the customary one-sided t-test at the 5% level of significance for 8 degrees of freedom, then the probability of declaring the treatment effect "significant" is slightly greater than 0.5 when it is completely ineffective  $\mu_t = \mu_c$ ; slightly greater than 0.3, when  $\mu_t = \mu_c - .5\sigma$ ; and about 0.15 when it is detrimental to the extent  $\mu_t = \mu_c - \sigma$ , where  $\sigma$  is the standard deviation of a single measurement.

#### SOME ASPECTS OF LIFE TABLES

Whitney L. Johnson, *Virginia Polytechnic Institute*

An elementary report giving the basic methods of construction of an abridged life table. An abridged life table for Virginia white males is presented using data from 1959. Trends toward longer expected life in general were noted. The affect of removal of a cause of death was presented with an illustration of removing death by accidental causes from the Virginia White Males - 1959 abridged life table. The expected increase in life was then given.

#### A STATISTICAL ANALYSIS OF A CROP ROTATION EXPERIMENT

Michael H. Kutner, *Virginia Polytechnic Institute*

This paper was concerned with an analysis of a crop rotation experiment. The experiment was a corn-wheat-clover rotation which was carried on for nine years under various fertilizer combinations (treatments).

Essentially, there were in the experiment two levels of fertilizer: 90 lbs/acre of phosphorous, 90 lbs/acre of potassium, and 180 lbs/acre of phosphorous, 180 lbs/acre of potassium, with the nitrogen kept constant. Fertilizer treatments included the placement of fertilizer on a particular crop in the rotation as against the placement of equivalent amounts of fertilizer on each crop in the rotation.

A study of the physical yields of the three crops individually was performed by analysis of variance techniques and the use of orthogonal

contrasts. A study of the total yield of a complete rotation for the three crops was made employing analysis of variance techniques on the total monetary returns using a specific set of prices. Also, a study was made on the variances of the total revenue within each treatment, so as to make inferences on the variation of total income due to the choice of treatments.

The results of the above procedures indicated that the high level of fertilizer produced statistically greater returns (monetary revenue). There were no statistically significant differences in returns over the various fertilizer placement treatments, although there was some evidence that the placement of all the fertilizer on the corn in the rotation produced higher returns.

Alternate analyses and recommendations were presented for future experimentation.

#### STATISTICAL INVESTIGATION OF TELLER PERFORMANCE IN BRANCH BANKING

S. P. Shao and T. J. Reed, *Norfolk College of William and Mary*

In this study the reporters were asked by a bank to investigate existing data statistically rather than to plan, collect, and analyze the data. The data available included the number of transactions by types and the dollar volumes by total receipts, total payments, and cash balance in a bank operating sixteen branches in a city area.

First, the average relationship between the number of transactions and the dollar volume was investigated by correlation analysis. A low degree of correlation was found.

The second analysis dealt with the efficiency of tellers' performance. Based on the analysis of variance techniques, it was found that there were wide variations among individual tellers' performances in the bank system as a whole, and that there were significant differences between tellers' performances within branches and that among branches.

The third analysis gives the indication of the seasonal variation of tellers' performance by days of week. Significant differences were observed in the index number patterns constructed for individual branches.

## News And Notes

*News contributions should be sent to either the editor or the section editors.*

### VISITING SCIENTISTS PROGRAM 1961-1962

Seven eminent scientists representing 3 professional societies, visited 14 Virginia colleges during the 1961-1962 academic year under the auspices of the Visiting Scientist Program of the University Center in Virginia. The American Institute of Biological Sciences granted requests from 8 institutions, the American Astronomical Society sent a lecturer to 3 institutions and the American Geological Institute arranged for one of its scientists to visit 3 Virginia institutions.

The American Society of Engineering Education agreed to work through the Center in the Visiting Scientist Program, however there were no requests for such a visitor through the center.

### ASTRONOMY, MATHEMATICS, AND PHYSICS SECTION

Robert W. Dickey retired as head of the Physics Department at Washington and Lee June 1961. He was succeeded by Edward F. Turner. Joining that department in September, 1961, were Thomas Ratchford, Assistant Professor, and William Keens, Instructor. The new science building providing over 20,000 square feet of floor space, is nearing completion. It will house physics and biology and will include a greenhouse and observatory as well as rooms for staff and undergraduate research.

Washington and Lee installed an IBM 1620 Computer in January for use in instruction and research as well as administrative records.

V.M.I. now has in operation its sub-critical assembly installed under a grant of \$24,407 from AEC. An additional grant of \$24,000 made possible the purchase of a 150 kev neutron generator providing for pulsed operation of the sub-critical.

The department of mathematics at V.M.I. reports that Wilbur C. Whitten, Jr. has returned from a leave of absence having earned the Ph.D. degree. Also joining the department in September was Capt. Henry R. Wier, U.S. Navy, retired. Col. K. S. Purdie retired June 1961.

A new building to house the departments of physics and mathematics at the College of William and Mary in Norfolk is expected to be occupied in the 1962-1963 session. In September, 1962, W. M. Pritchard will join the department from Georgia Tech and Newport News Shipbuilding and



Drydock Co. Coming to the department from Drury College will be Armando Roderiquez.

Dudley B. Selden, U. S. Army, retired, has been appointed instructor of mathematics at Hampden-Sydney College. Col. Selden is a graduate of the University of Richmond and received the Master's degree from Purdue.

The V.P.I. Mathematics Department has, as Centennial Visiting Lecturer, Professor Chih-Bing Ling. Professor Ling is a graduate of the Institute of Academia Sinica, Taiwan, China.

The section welcomes the return to Virginia of Dr. T. M. Hahn, formerly of the physics department, now president of V. P. I.

Effective in July, 1962, Frank L. Hereford will become chairman of the Physics Department at the University of Virginia. J. W. Beams will retire as chairman but will continue as Smith Professor of Physics. Stephen Berke resigned to accept a position at Brandeis University, Waltham, Mass. Joinning the department in 1961 were Morris E. Rose of the Oak Ridge National Laboratory, and Rogers C. Ritter. Ludwig J. Weigert is Visiting Assistant Professor.

Frederick L. Brown, long active in this section, retired from the University of Virginia in the summer of 1961 and is now Professor Emeritus. In April Dr. Brown served with Dr. Dieke, Chairman of the Physics Department at Johns Hopkins, as Visiting Consultants at V.M.I. They met with students and faculty and make recommendations concerning course content, texts, and curriculum in the physics department.

D. Rae Carpenter, Jr., *Section Editor*

## SECTION OF BIOLOGY

Teruo Nishida, Chief, Research Section, National Gamma Field, Tokyo, Japan, recently spent five months in the United States studying especially the use of irradiation in the treatment of horticultural seeds and plants for plant breeding purposes. Short periods were spent at Beltsville, Md.; Raleigh, N. C.; Oak Ridge, Tennessee; Gainesville, Fla.; Geneva, New York; and Davis, California. Mr. Nishida worked for several months with W. S. Flory at the University of Virginia's Blandy Experimental Farm.

Mary B. Humphreys joined the Northeastern Section of the Botanical Society of America for a field trip during June.

Morris L. Brehmer and J. Ernest Warinner of the Virginia Institute of Marine Science received approval of an \$11,711 grant from the U. S. Public Health Service, Division of Water Supply and Pollution Control. They will study the effects of thermal effluents on marine organisms.

Edwin B. Joseph, Virginia Institute of Marine Science, has been awarded a grant by the National Science Foundation for \$16,500 for the study of the ecology of the pelagic embryos and larvae of marine fishes.

James Norman Dent and W. Ralph Singleton of the Department of Biology, University of Virginia, have received funds from the Atomic Energy Commission for the continuation of their researches. Professor Dent received \$10,000 and Professor Singleton \$18,000.

W. Ralph Singleton, Miller Professor of Biology and Director of the Blandy Experimental Farm of the University of Virginia was the guest of EUCARPIA, the Association of Plant Breeders of Western Europe, at their meetings in Paris on 21-24 May. Professor Singleton lectured on *Mutation Breeding*. He and Mrs. Singleton also visited London and Amsterdam while they were in Europe.

Jesse C. Thompson, Jr., Hollins College, has been selected for participation in the U. S. Biology Program of the International Indian Ocean Expedition during the summer of 1963. His research will deal with the morphology and the taxonomy of the ciliated protozoa.

The Virginia Institute of Marine Science has recently received from M. F. Maury Werth a gift of the table and stools used by Commodore Mathew Fontaine Maury while working as Superintendent of Charts and Instruments, the forerunner of today's U.S. Naval Observatory and Hydrographic Office. The Mariners Museum has donated a bust of Maury modeled by Edward V. Valentine in 1869. It is displayed in the Library of the Institute along with the table and benches donated by Mr. Werth.

The field laboratory at Wachapreague, Virginia has been completed and is now occupied by a staff of four under the direction of Michael Castagna. Its dormitories and other facilities are available to investigators from the College as well as from the Institute.

Wyman Harrison, who has been on the faculty of the Norfolk Division of the College of William and Mary, became a member of the staff of the Virginia Institute of Marine Science April 1, 1962. Dr. Harrison is serving as geological and physical oceanographer.

Eight college teachers from eight different colleges and universities from Virginia and four other states have been accepted into the NSF-Research Participation for College Teachers Program to carry on marine-oriented research for 12 weeks this summer at the Institute of Marine Science. Ten undergraduates from 6 states besides Virginia will also be given the opportunity to gain experience in conducting marine research under the NSF-Undergraduate Research Participation Program at the Institute from June 11 to August 31.

Jesse Thompson, Jr., *Section Editor*

## CHEMISTRY SECTION

J. Samuel Gillespie, Jr. has been named a Senior Research Scientist at the Virginia Institute for Scientific Research. Dr. Gillespie has been President of Commonwealth Laboratory Incorporated of Richmond and a member of the firm of Cox and Gillespie, consulting chemists and engineers.

M. A. Kise, *Section Editor*



## LIST OF MEMBERS

### 1961 – 1962

Note: Following are the types of membership in the Academy:

\*\*\**Patrons*, who contribute \$1000 or more to the Academy.

\*\**Life Members*, who contribute \$100 or more to the Academy.

\*\**Honorary Life Members*, who are elected by Council.

*Business Members*, who pay annual dues of \$100.

\**Sustaining Members*, who pay annual dues of \$10.

—*Contributing Members*, who pay annual dues of \$5.

*Regular Members*, who pay annual dues of \$3.

*Student Members*, (college students only) who pay annual dues of \$1.

The number following a name designates the section, or sections, to which a member belongs.

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|--|----------------------|
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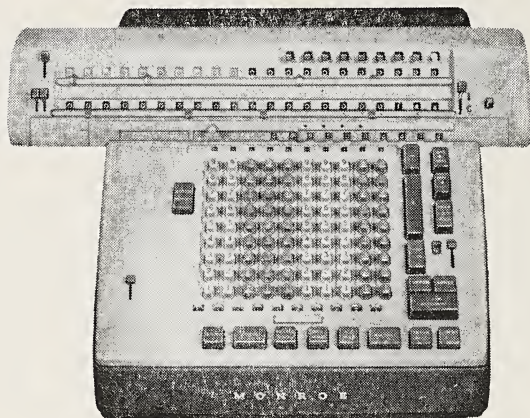


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